
Gedaente en vpdoeninge vant Landt van Portugal, alst drie mijlen van v is, en daer beneffens zeijlt.
Sanctrego.
Als dit Swarte hoeuelken oost te zuijden van v leijt, soe ißmen open voor die Riuier van Aueiro.
Montego.
PORTVGALLIÆ PARS.
Barcado.
Barca.
Ville del Conde.
Mogera.
Niuos.
Esposendo.
Carico.
Zurara.
Metellin.
S. Iuan de Foz.
Aleixo.
Muistrol.
Port de Marzegaij.
Port de Port.
Duero Rio.
Ville noua.
Grege.
S. Catelina.
Closter.
Sout landt.
Aueiro.
Incasa.
Die Riuier van Aueiro.
Sout landt.
Sout landt.
Ouia.
Lagos.
Mira.
Cepo de Montego.
SEPTENTRIO N.
MERIDIES Z.
ORIENS O.
OCCIDES
Cum Priuilegio ad decennium.
Die Zee Caerte van Portugal, tußchen Camino en Montego, alsoe dat landt all daer in sijn ghedaente is, met alle sijne haeuen enn ondiepten, met groeter naersticheijt en vliedt ghecorrigeert doer
Lucas Ianß Waghenaer vā Enchuijsen.
1583
Spaensche mijlen tot 17½. in een graedt.
Duijtsche mijlen tot 15. in een graedt.
DIE WESTER ZEE.

1. ***INTRODUCTION***
2. ***Hydrographic Practice***
3. ***Geodesy/positioning***
4. ***Water Levels***
5. ***Bathymetry/Depth Determination***
6. ***Hydrographic Data Handling***

Hydrographic Survey History


Gedaente en vpdoeninge vant Landt van Portugal, alst drie mijlen van v is, en daer beneffens zeijlt.
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Spaensche mijlen tot 17½. in een graedt.
Duijtsche mijlen tot 15. in een graedt.
DIE WESTER ZEE.

Introduction to Surveying

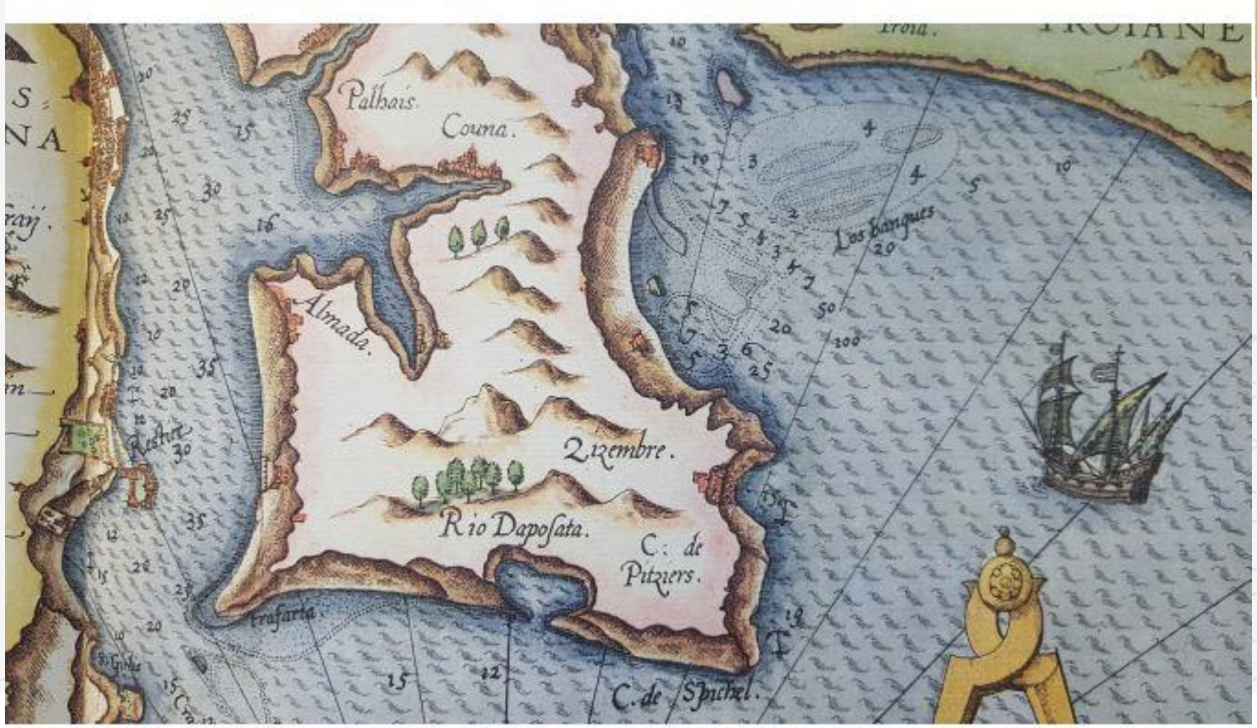
Also known as underwater surveying, hydrography is the science of determining the features of an underwater area. The features to be studied include the water depth, topographic features, tide measurement etc. Simply put, being able to understand the contortions and elevations of the ocean floor has many practical uses.

An important type of hydrographic surveys is the bathymetric survey, which originates from the Greek terms bathus (deep) and metron (measurement). This is the underwater equivalent to a land survey operation known as hypsometry.

The profession of hydrographer is built upon measurement accuracy. Ever since Lucas Janszoon Waghenaer produced the first true nautical charts in 1584, hydrographers have been working to improve the accuracy of their measurements.

For anyone fortunate enough to have reviewed Waghenaer’s atlas, the 'Spieghel der Zeevaert' (The Mariner’s Mirror), one of the first questions that comes to mind is how accurate are these charts? As the technology of the times was crude at best, it would be difficult to evaluate his charts by modern standards. However, two soundings stand out as indicative of both the relative accuracy of his data and Waghenaer’s integrity.

Waghenaer's Chart No. 17. It is oriented with North to left. 200 fathom sounding on north wall of Subetal Canyon is to east of Cape Spichel.



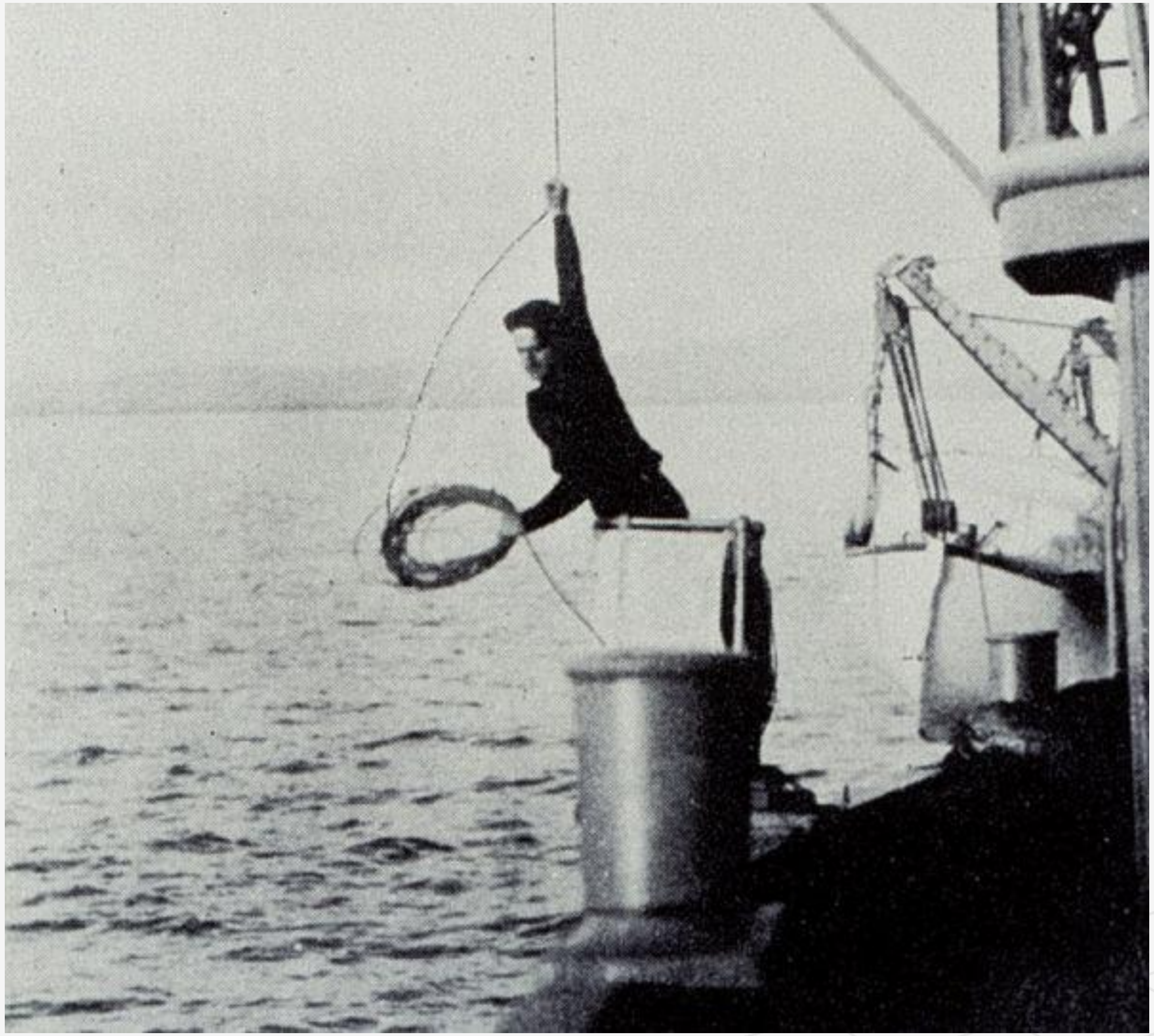
His first publication, Spieghel der zeevaerdt ("Mariner's mirror"), appeared in 1584.[2] This chart-book combined an atlas of nautical charts and sailing directions with instructions for navigation on the western and north-western coastal waters of Europe.

It was the first of its kind in the history of nautical cartography, and was an immediate success. A second part was published the next year and was reprinted several times, and translated into English, German, Latin, and French

Next revolution

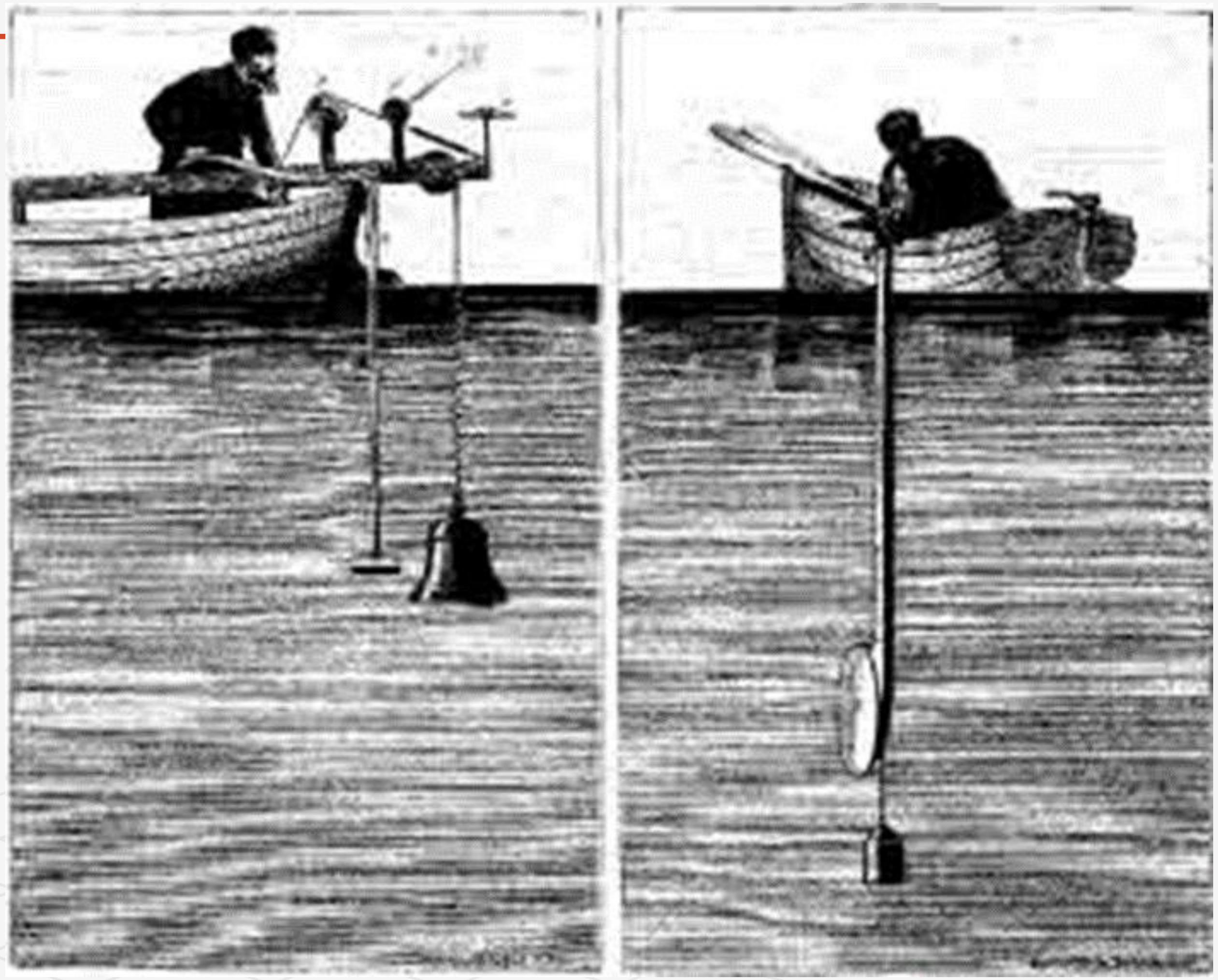
For the next 340 years, little was done to improve the accuracy of depth sounding instrumentation. The hydrographer was constrained to using the lead line. However, positioning technology began improving in the eighteenth century with the invention of octant, sextant, chronometer and station pointer.

These inventions, coupled with the evolving understanding that depth information had to be placed in the same geographic framework as the shoreline and landmarks shown on charts, led to a quantum leap in the accuracy of charts. This new understanding was driven by the work of such British hydrographers as Murdoch Mackenzie Senior, Murdoch Mackenzie Junior, Graeme Spence and the incomparable James Cook.



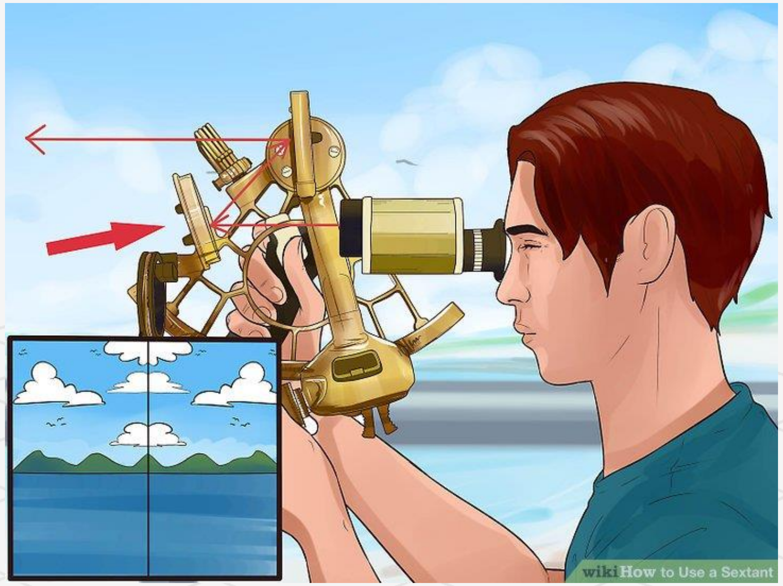
Leadline sounding operation. (Photo: 1928 and 1931, Hydrographic Manual)

In 1826 on Lake Geneva, Switzerland, Jean-Daniel Colladon, a physicist, and Charles-Francois Sturm, a mathematician, made the first recorded attempt to determine the speed of sound in water. In their experiment, the underwater bell was struck simultaneously with ignition of gunpowder on the first boat. The sound of the bell and flash from the gunpowder were observed 10 miles away on the second boat. The time between the gunpowder flash and the sound reaching the second boat was used to calculate the speed of sound in water.



In 1747, Mackenzie Senior was the first hydrographer to develop a local triangulation scheme during his survey of the Orkney Islands. He then went on to describe his methodology of measuring a baseline, developing a triangulation network, building "beacons, or landmarks" over prominent points in the network, and then positioning his sounding boat by taking intersecting compass bearings to these points during sounding operations.

Murdoch Mackenzie rectified this situation in 1775 with the invention of the station pointer, or as it is known in the United States, the three-arm protractor. This instrument allowed hydrographers to plot three-point sextant fixes which resulted in horizontal accuracies of less than ten metres within the bounds of the triangulation scheme.



Revolution of Echosounder

Reginald Aubrey Fessenden (October 6, 1866 – July 22, 1932) was a Canadian-born inventor, who did a majority of his work in the United States. During his life he received hundreds of patents in various fields, most notably ones related to radio and sonar.

- Reginald Aubrey Fessenden (October 6, 1866 – July 22, 1932) was a Canadian-born inventor, who did a majority of his work in the United States. During his life he received ~~hundreds of patents in various fields, most notably ones related to radio and sonar.~~

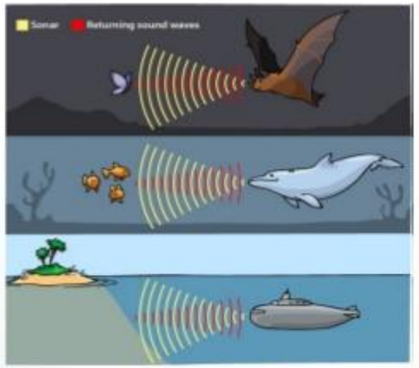
- his most extensive work was in marine communication as consulting engineer with the Submarine Signal Company which built a widely used aid to navigation using bells, termed a submarine signal, acting much as an underwater foghorn. While there, he invented the Fessenden oscillator, an electromechanical transducer.

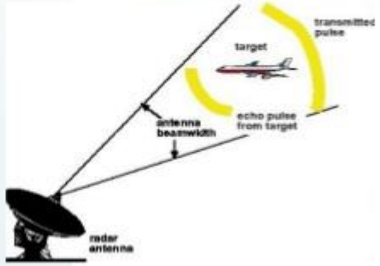
- Though the company immediately began replacing bells and primitive receivers on ships with the new device, it was also the basis for entirely new applications: underwater telegraphy and sonic distance measurement. **The later was the basis for sonar (SOund NAvigation Ranging), echo-sounding and the principle applied to radar (RAdio Detection And Ranging). The device was soon put to use for submarines to signal each other, as well as a method for locating icebergs, to help avoid another disaster like the one that sank Titanic**. While the company quickly applied his invention to replace the bells of its systems and entered acoustic telegraphy it ignored the echo ranging potential. ***The echo sounding was invented in 1912 by German pyhsicist Alexander Behm***

RADAR vs. SONAR

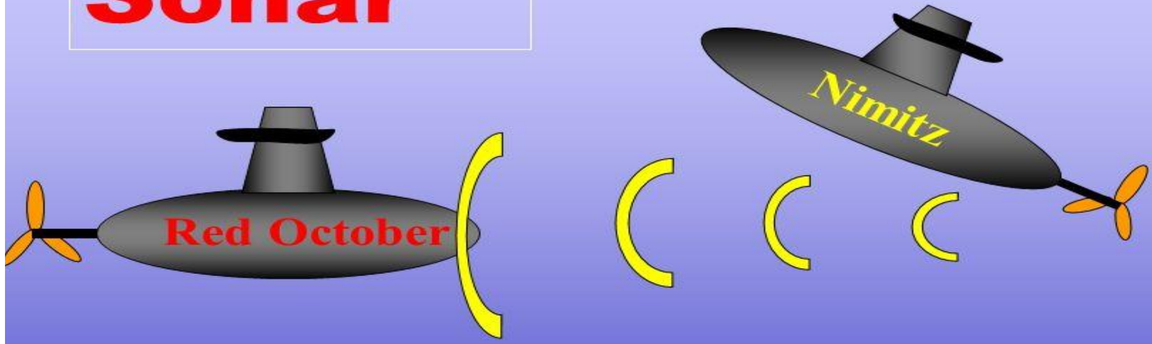
- SONAR uses sound waves
  - **SO**und **N**avigation **A**nd **R**anging
  - frequencies of 20,000 Hz to 10,000,000 Hz
  - waves travel at about 343 meters per second in air
- RADAR uses radio waves (electromagnetic waves)
  - **RA**dio **D**etecting **A**nd **R**anging
  - frequencies of 3,000,000 Hz to 300 billion Hz
  - waves travel at almost 300 million meters per second in air

Which one gives better results?





Passive Sonar



Sound from the engines and propeller of the Nimitz are detected by sonar operators on the Red October. When they hear the sound they know the Nimitz is there.

Basic Sonar Distance Calculation

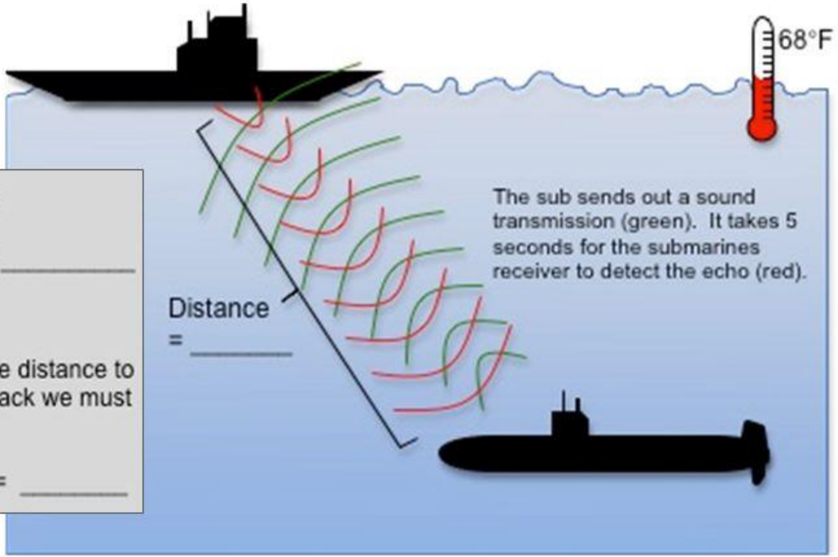
D = speed X time/2

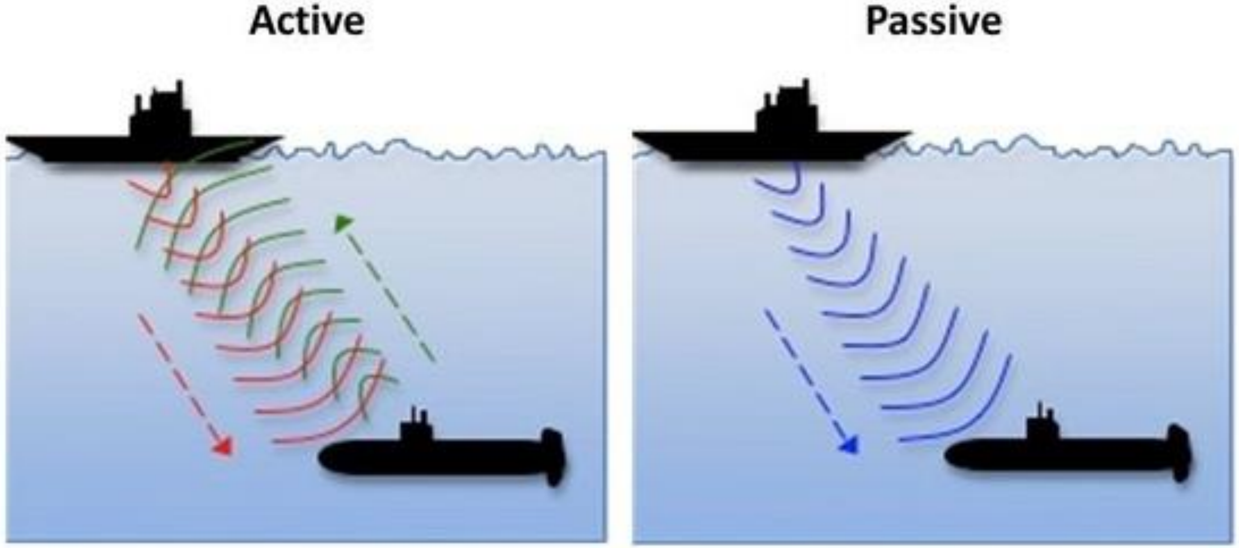
Speed of sound in ocean water = __________

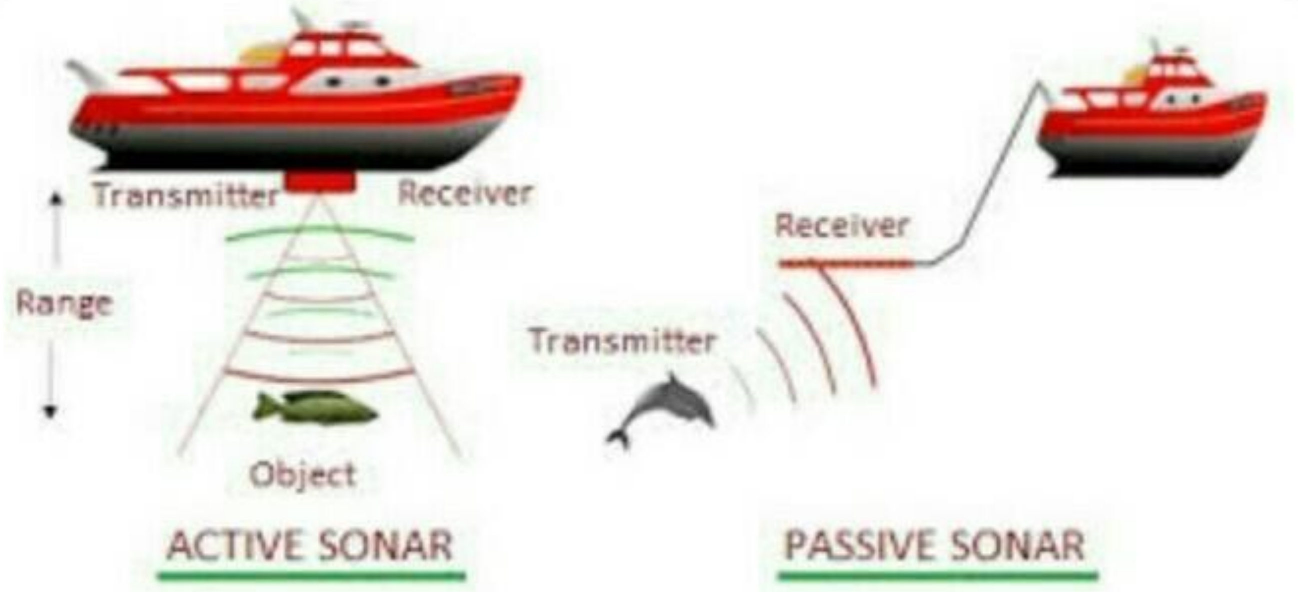
Time = ____ seconds

Because we only want to know the distance to the ship and not to the ship and back we must divide by 2.

Distance = ________ X ______ = ________







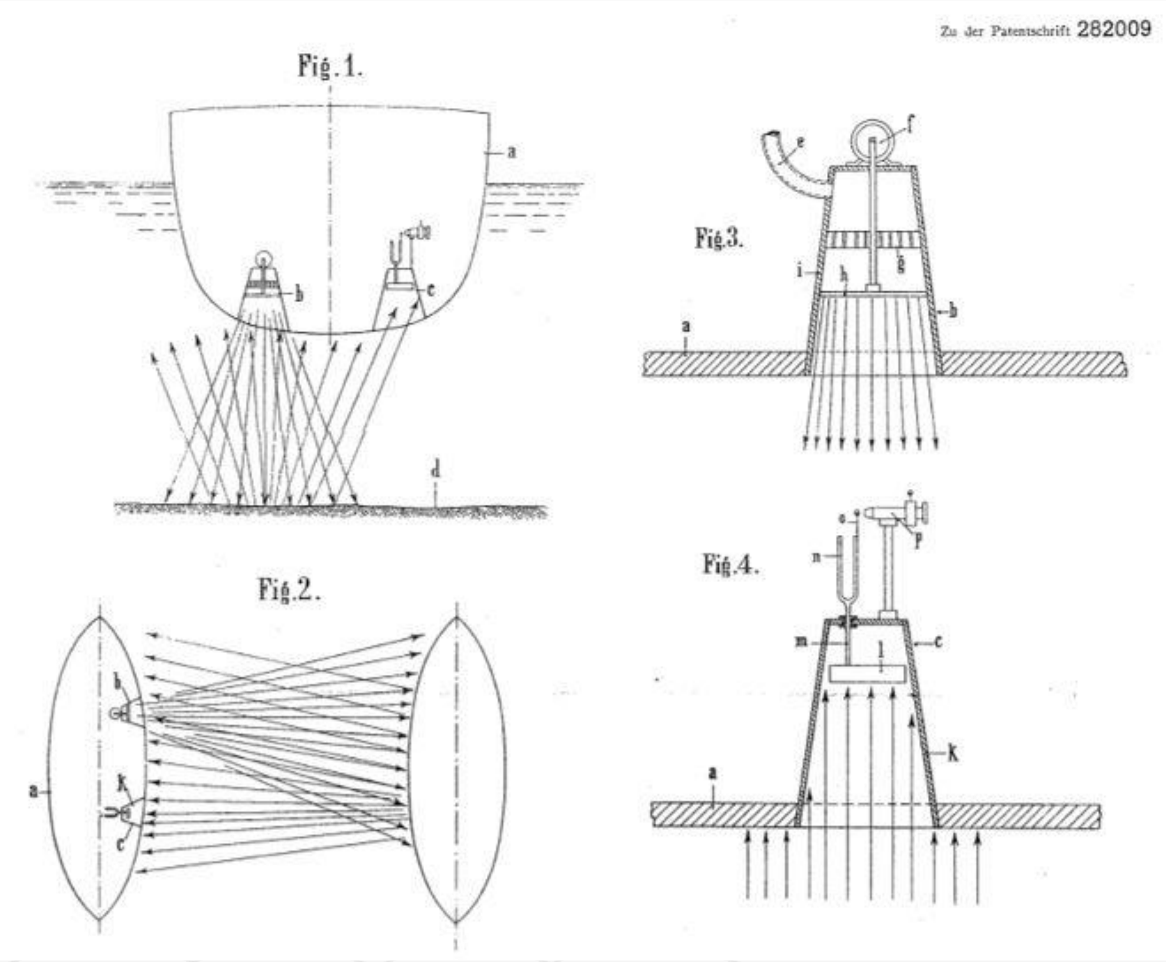
Both **radar** and **sonar** locate objects from the echo of a signal that is bounced off the object. **Radar** uses radio waves, which are a type of electromagnetic energy. **Sonar** uses the echo principle by sending out sound waves underwater or through the human body to locate objects.

Alexander Behm (11 November 1880, in Sternberg (Mecklenburg) – 22 January 1952, in Tarp (Schleswig-Flensburg)) was a German physicist who developed working ocean echo sounder in Germany at the same time Reginald Fessenden was doing so in North America.

As head of a research laboratory in Vienna (Austria) he conducted experiments concerning the propagation of sound. He tried to develop an iceberg detection system using reflected sound waves after the Titanic disaster on 15 April 1912. In the end reflected sound waves proved not to be suitable for the detection of icebergs but for measuring the depth of the sea, because the bottom of the sea reflected them well. Thus, echo sounding was born.

Behm was granted German patent No. 282009 for the invention of echo sounding (device for measuring depths of the sea and distances and headings of ships or obstacles by means of reflected sound waves) on 22 July 1913.

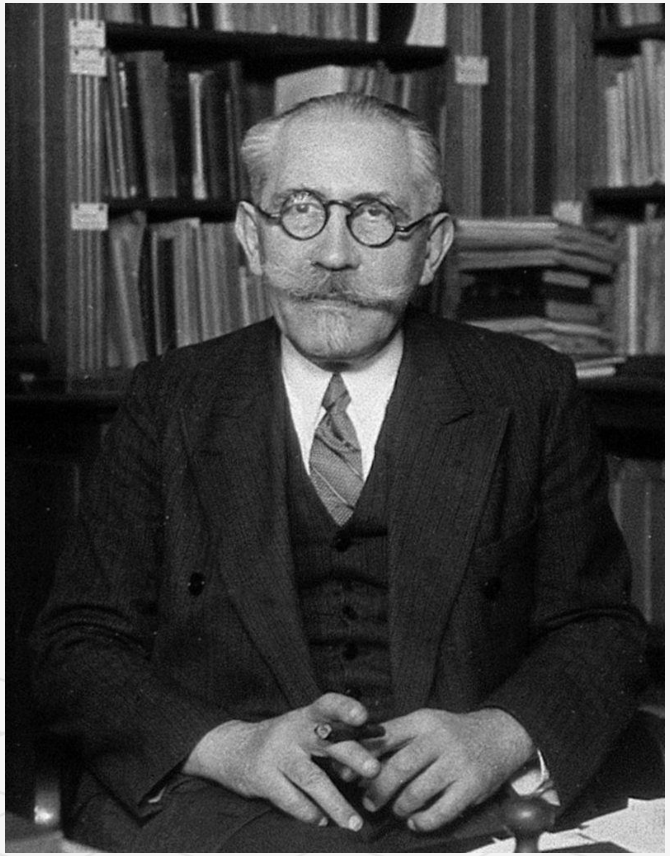

Behmlot
alamy stock photo
DYYD2T
www.alamy.com

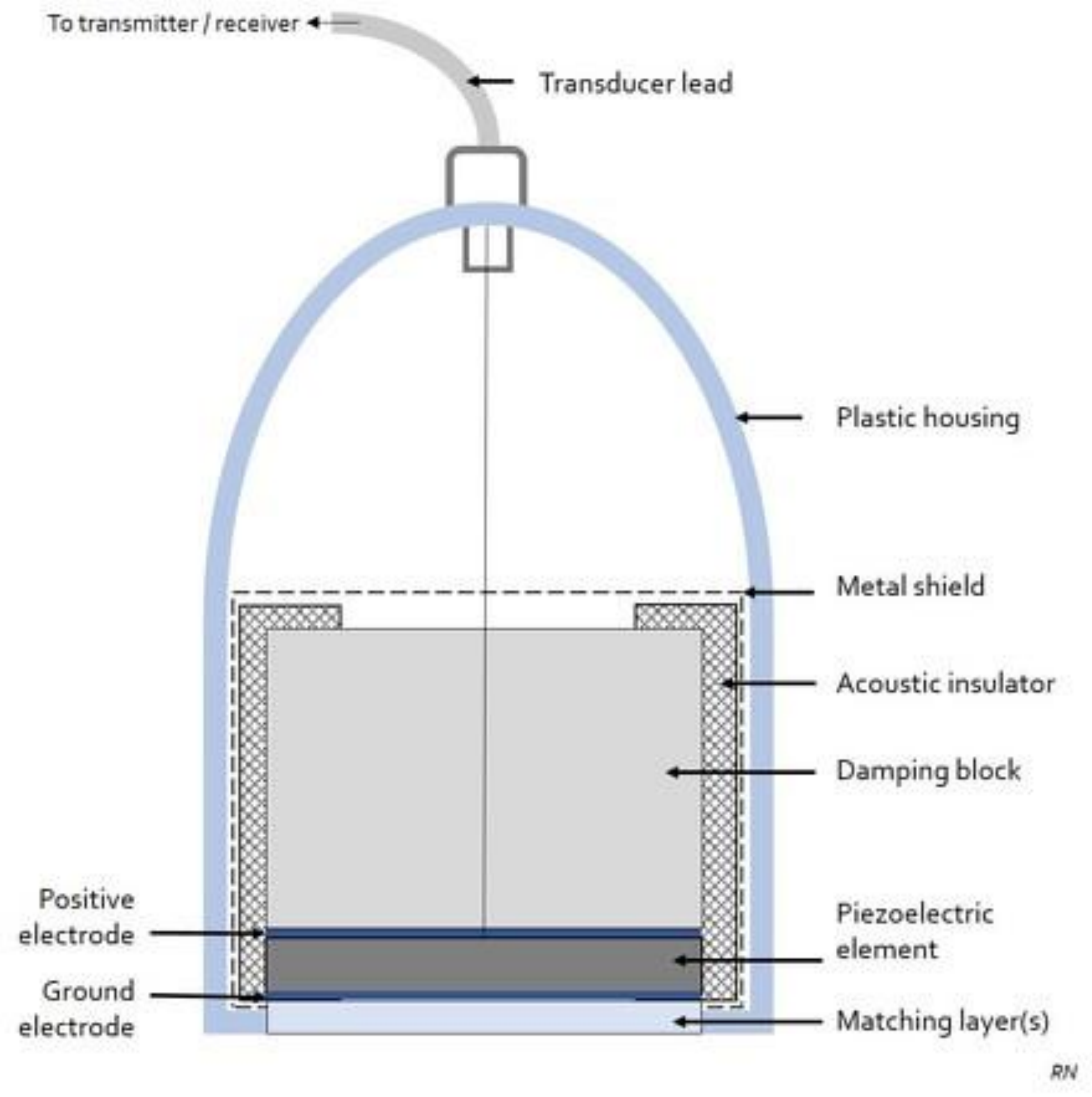

Zu der Patentschrift 282009
Fig. 1.
Fig. 2.
Fig. 3.
Fig. 4.

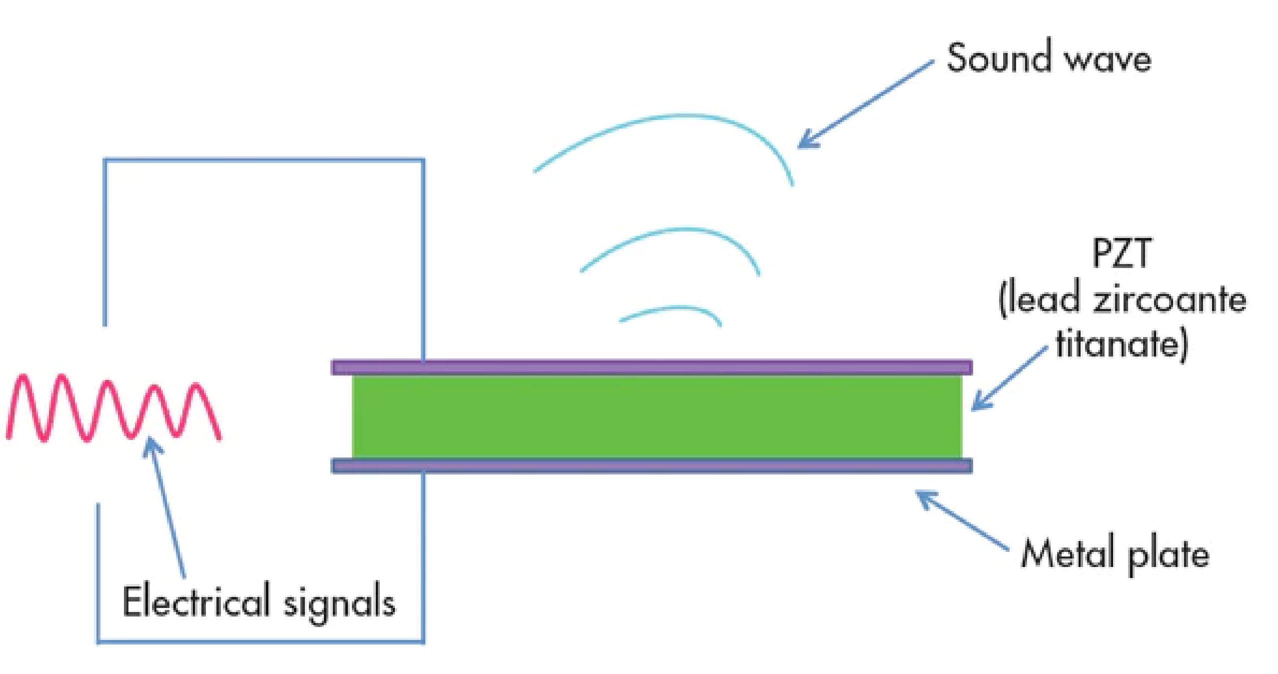
Langevin was born in Paris, and studied at the École de Physique et Chimie[4] and the École Normale Supérieure. He then went to the University of Cambridge and studied in the Cavendish Laboratory under Sir J. J. Thomson.

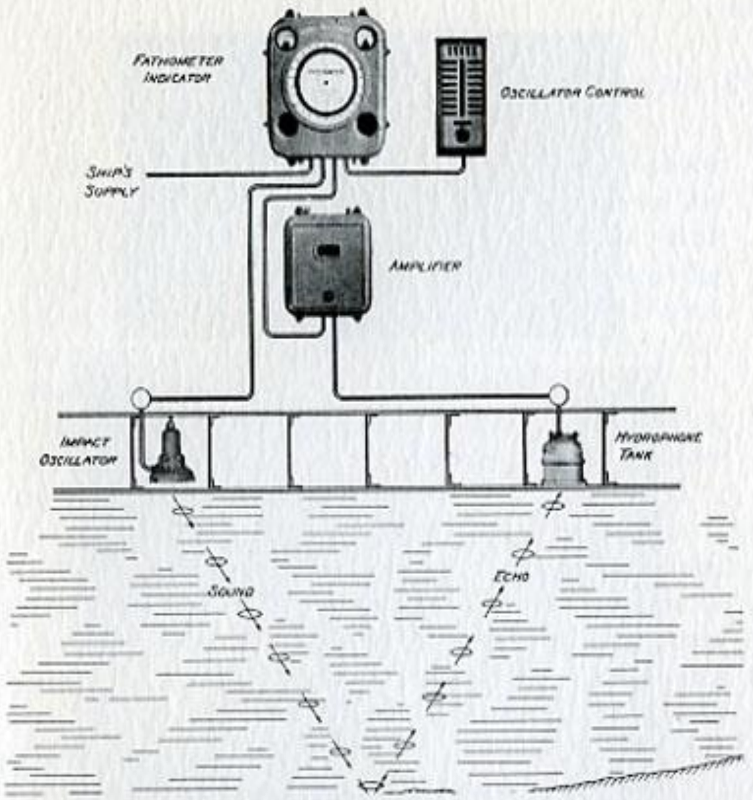
Langevin is noted for his work on paramagnetism and diamagnetism, and devised the modern interpretation of this phenomenon in terms of spins of electrons within atoms.[6] His most famous work was in the use of ultrasound using Pierre Curie's piezoelectric effect.

In 1916 and 1917, Paul Langevin and Chilowsky filed two US patents disclosing the first ultrasonic submarine detector using an electrostatic method (singing condenser) for one patent and thin quartz crystals for the other. The amount of time taken by the signal to travel to the enemy submarine and echo back to the ship on which the device was mounted was used to calculate the distance under water.

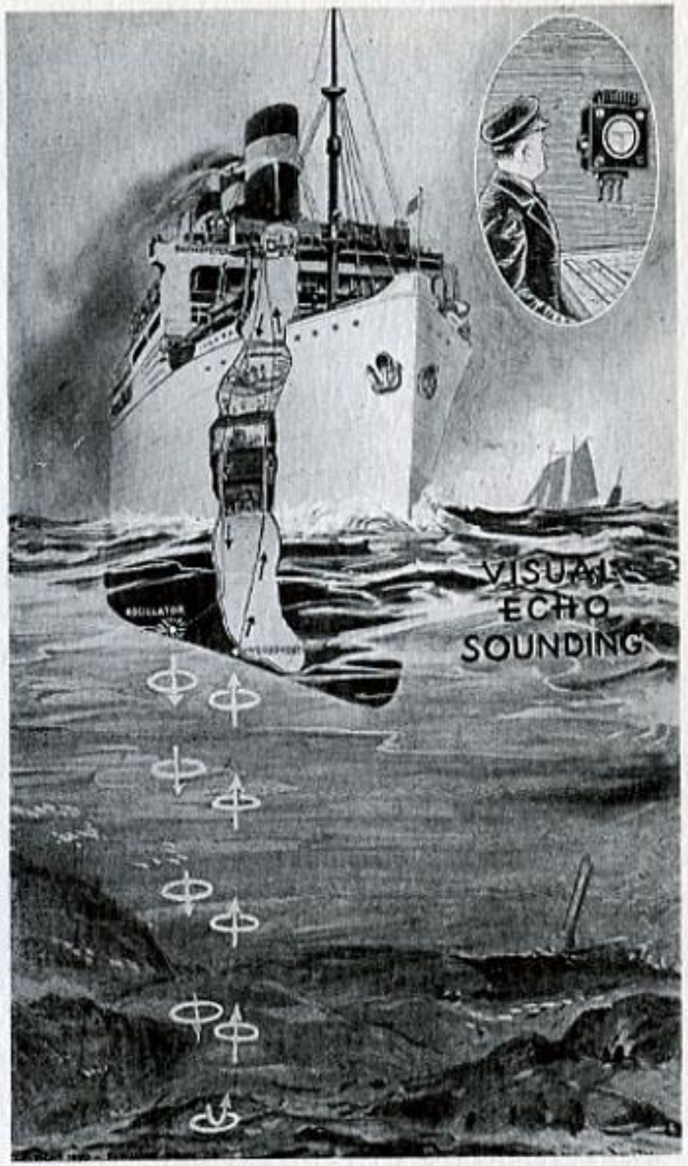



To transmitter / receiver
Transducer lead
Plastic housing
Metal shield
Acoustic insulator
Damping block
Positive electrode
Piezoelectric element
Ground electrode
Matching layer(s)
RN


Sound wave
PZT (lead zircoante titanate)
Electrical signals
Metal plate



THE FATHOMETER SYSTEM — The system shown in these pictures consists of three units: the Fathometer Indicator with its accompanying Amplifier; the sound-producing Oscillator in conjunction with the Oscillator Control; and the sound-receiving Hydrophone. The black arrows in the picture at right indicate electrical impulses and the white rings and arrows indicate sound waves.



One of the first commercial echo sounding units was the Fessenden Fathometer, which used the Fessenden oscillator to generate sound waves. This was first installed by the Submarine Signal Company in 1924 on the M&M liner S.S. Berkshire

Hydrographic Survey in Malaysia

Topographic , bathymetry and Hydrography…..

WHAT'S THE DIFFERENCE?

Topographic

bathymetry

Hydrography

Between them?

Topographic , bathymetry and Hydrography…..

Topographic maps show elevation of landforms above sea level; bathymetric maps show depths of landforms below sea level. ... Bathymetric maps show depths of landforms below sea level. Topographic elevations and bathymetric depths are often shown on maps with contour lines.

Bathymetry is the foundation of the science of hydrography, which measures the physical features of a water body.

Hydrography includes not only bathymetry, but also the shape and features of the shoreline; the characteristics of tides, currents, and waves; and the physical and chemical properties of the water itself.

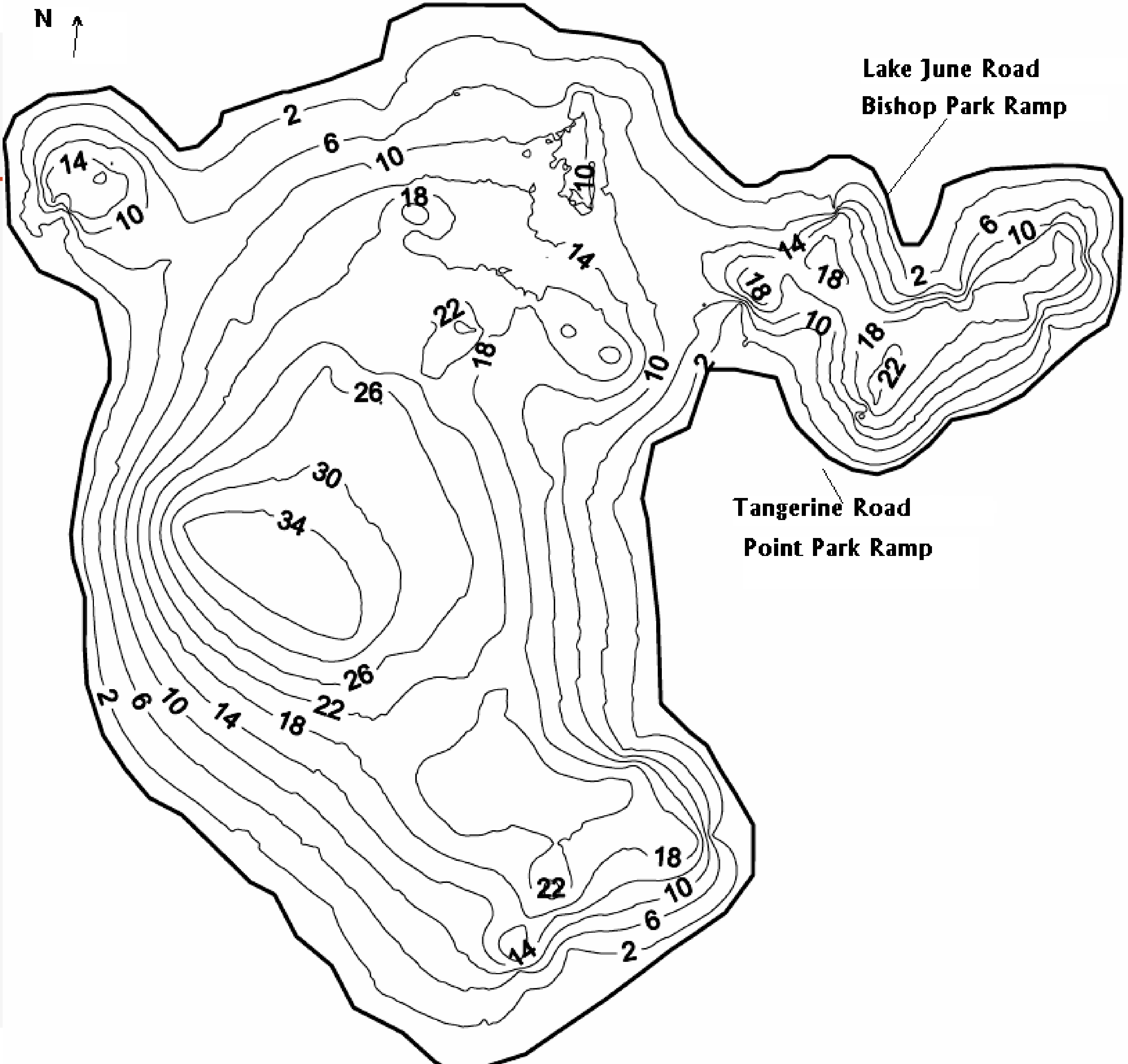
What is bathymetry? Bathymetry is the study of the "beds" or "floors" of water bodies, including the ocean, rivers, streams, and lakes.

The term "bathymetry" originally referred to the ocean's depth relative to sea level, although it has come to mean “submarine topography,” or the depths and shapes of underwater terrain.

In the same way that topographic maps represent the three-dimensional features (or relief) of overland terrain, bathymetric maps illustrate the land that lies underwater. Variations in sea-floor relief may be depicted by color and contour lines called depth contours or isobaths.

Bathymetry is the foundation of the science of hydrography, which measures the physical features of a water body. Hydrography includes not only bathymetry, but also the shape and features of the shoreline; the characteristics of tides, currents, and waves; and the physical and chemical properties of the water itself.

Bathymetric map, chart that depicts the submerged topography and physiographic features of ocean and sea bottoms. Individual soundings, or points at which the depth to the seafloor have been measured, are given; however, the principal technique for expressing the submarine topography involves drawing contour lines that connect all measured and extrapolated points at the same depth below sea level.



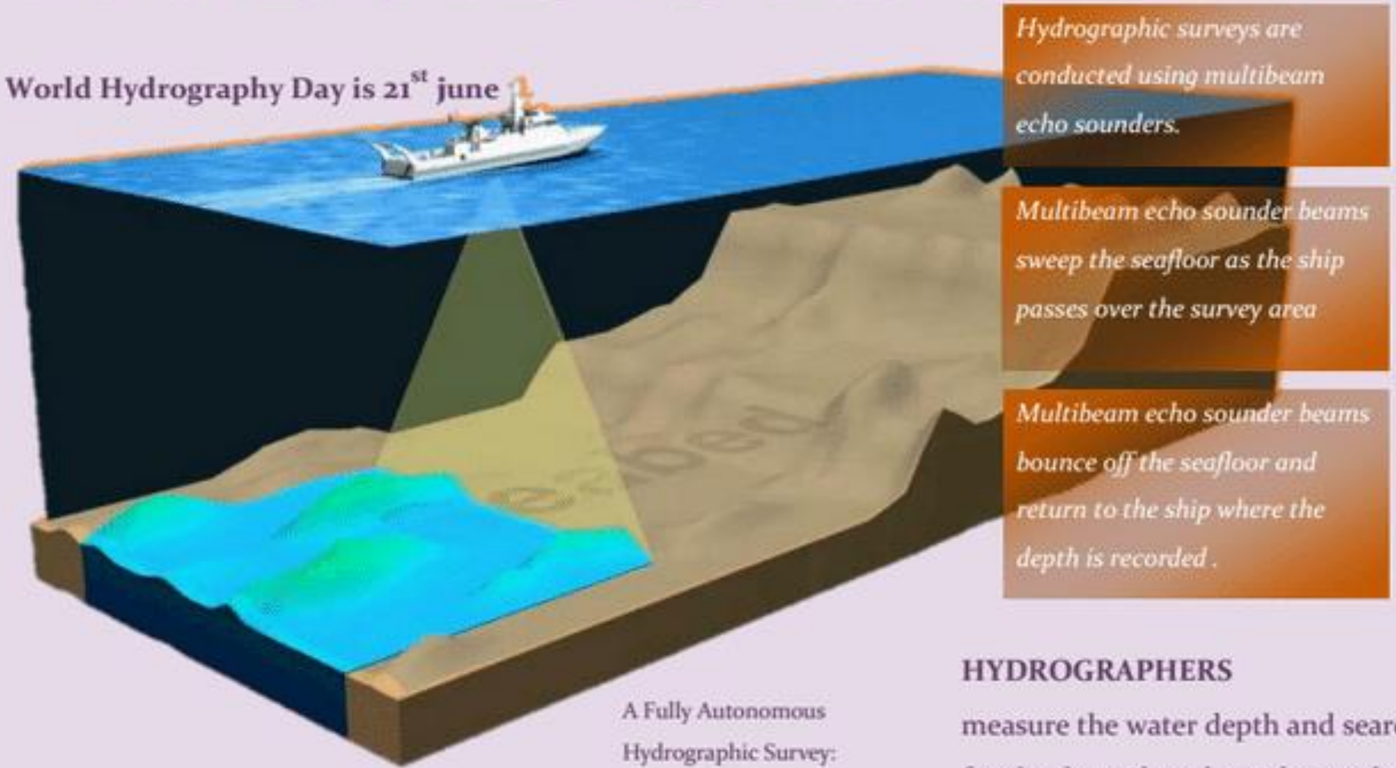
Comparison Bathymetry plan with hydrographic chart

A bathymetric chart differs from a hydrographic chart in that accurate presentation of the underwater features is the goal, while safe navigation is the requirement for the hydrographic chart.

A hydrographic chart will obscure the actual features to present a simplified version to help mariners avoid underwater hazards.

HYDROGRAPHY

World Hydrography Day is 21st june



HYDROGRAPHERS

measure the water depth and search for shoals ,rock and wrecks are that could be hazard to navigations.

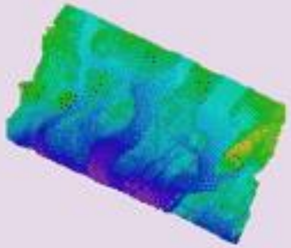
The also collect information on:

- Water level and tides
- Current
- Temperature
- Salinity

Products from hydrographic data

A Fully Autonomous Hydrographic Survey: No Line Plan, No Boat Crew, Just Sensors.

NAUTICAL CHARTS



HYDROGRAPHIC MODELS

Autonomous Underwater Vehicles (AUV)

The primary goal of hydrographic survey is to measure and describe features of the seabed and coastal areas in order to maintain safe navigation and marine activity.

Key tools in hydrographic survey these days are multibeam and interferometric sonars, which provide millions of measurements, or soundings, of the seafloor, and airborne LiDAR, providing nearly as dense datasets in coastal and shallow waters.

This dense data must be quickly evaluated, processed, decimated, and made into products such as Electronic Navigation Charts that can be used by mariners.

1. Hydrography

Hydrography is the branch of applied science which deals with the measurement and description of the physical features of oceans, seas, coastal areas, lakes and rivers, as well as with the prediction of their change over time, for the primary purpose of safety of navigation and in support of all other marine activities, including economic development, security and defense, scientific research, and environmental protection.” ***International Hydrographic Organization*** – June 2009


HYDROGRAPHIC SURVEYING
Uses of Hydrographic Surveys include:
✓ Determining the depth of the sea bed.
✓ Measuring river and stream discharge.
✓ Locating sewer fall by measuring direct currents.
✓ Planning massive structures such as bridges, dams harbours.
✓ Identifying scouring, silting and irregularities of the bed.
✓ Measuring Tide.
✓ Locating mean sea level.
✓ Determining the shore lines.
✓ Preparing Navigation Charts.
Navigation
Dredging
Oil & Gas Drilling
Navigation
Pipe Construction
Oil & Gas Drilling
Dredging
Pipe Construction

In the past 20 to 30 years technological advances have allowed us to discover and map much more detailed coastal and ocean bathymetry and to delineate shore boundaries , mostly through acoustic remote sensing.

Hydrography is that branch of physical oceanography that deals with measurement and definition of the configuration of the bottoms and adjacent land area of oceans, lakes, harbors, and other water bodies on Earth. Hydrographic surveying, in the strictest sense, is defined merely as the surveying of a water area; however, in modern usage it may include a wide variety of other objectives such as measurements of tides, currents, gravity, and the determination of physical and chemical properties of water.

The primary purpose of hydrographic surveying is in water depth estimation, which is achieved by bathymetric surveys. Some of the other most common uses of hydrographic surveying include waterway planning, dredging analysis, and wreck location.

Another application of surveying is in the construction and planning for docks, harbours, and dams.

It is important to ensure that the water depth in and around ports are sufficient to allow for ships to safely enter and berth. Also, the portion of the seabed that supports floating structures must have a strong foundation. Dams also require adequate knowledge of the surrounding terrain to ensure structural strength.

Surveying allows engineers to plan land reclamation activities. By revealing data on the seabed composition and topography, sites to carry out reclamation can be selected. In addition, engineers can determine the feasibility of projects in the planning phase itself. Surveying also aids in flood control systems, by predicting possible flooding zones and suggesting measures to effectively counter this. Flooding zones can be predicted by studying how the ocean floor changes around the coastline and by correlating this structure with any historic records of flooding or tsunamis.

Surveying also helps in ship navigation, by providing possible paths that a vessel can take. Certain ocean routes may lie at low depths or may have rocks and coral deposits. This poses a major danger to ships and hence needs to be recorded properly. By charting safe routes that do not cross any dangerous terrain, surveying helps the shipping industry. Surveying also has agricultural uses, by determining alluvial and silt deposits near water bodies. As deltas have incredibly fertile lands, such areas can be specifically allotted for farming activities. Also, by studying river discharge, erosion and its effects on arable land can be studied.




Seaweed planting

Hydrographic Survey in Malaysia

1. ***Local Authorities***

- JUPEM,
- Marine Department,
- Ports Authority,
- Fisheries Department,
- Royal M’sia Navy,
- JPS,
- Jabatan Warisan,
- JKR
- JMG
- Local Authority…..

2. **The contractor/Licenced Land Surveyor.**

- Construction e.g, Jetties, Bridge, Reclaimation,
- Sand Mining,
- Dredging,
- Pipe laying

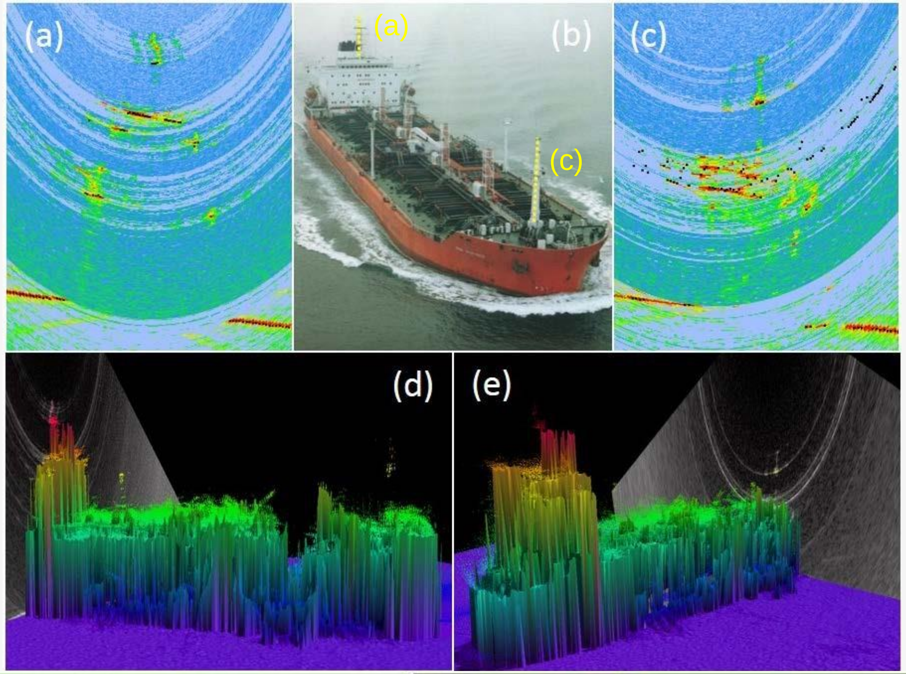
…….

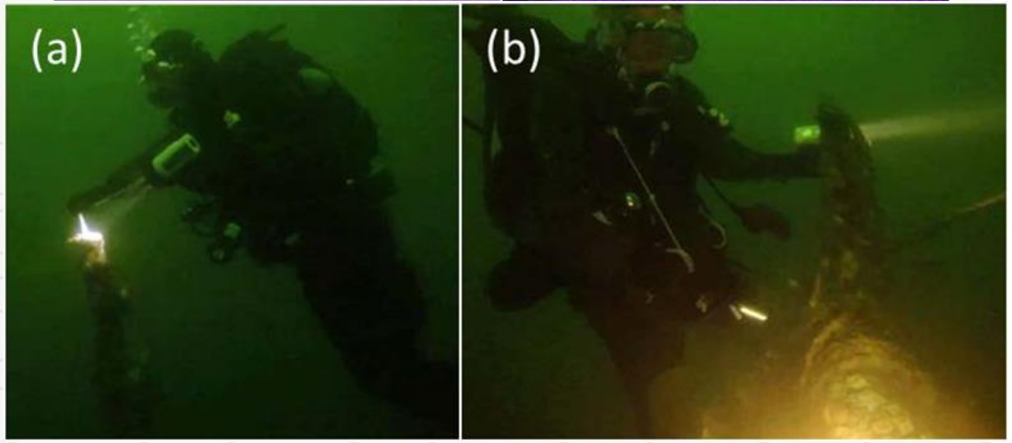
Using Multibeam Echosounders for Hydrographic Surveying in the Water Column: Estimating Wreck Least Depths – Marine Department safety of Navigation in Malaysia Water

Shipwrecks are important in the field of hydrography because superstructure of sunken wrecks can extend into the water column and pose a danger to navigation.

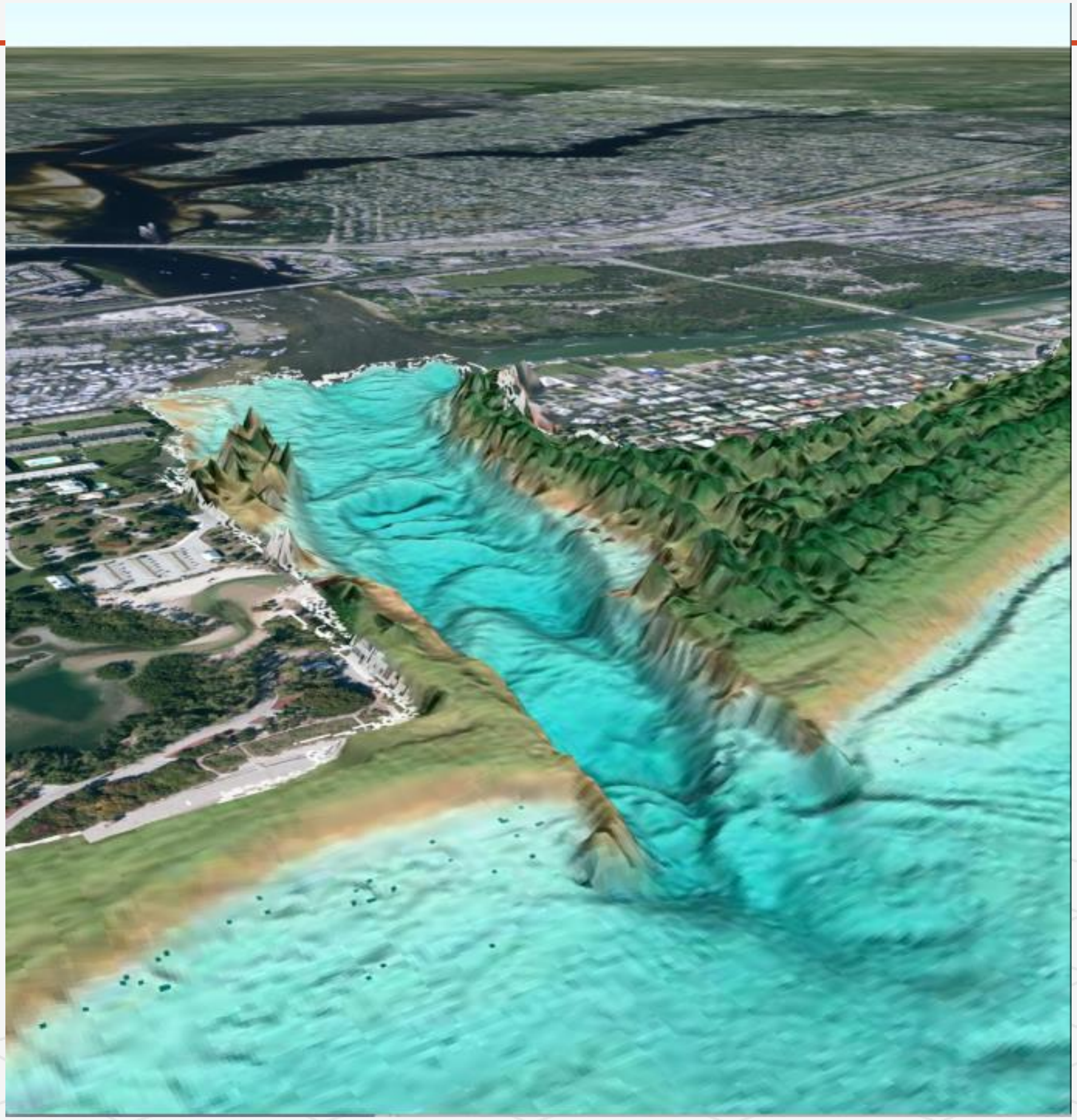
Hydrographers use to find the shallowest point of the wreck, known as the least depth, include: leadline cast, wire drag, diver investigation, side scan sonar shadow length, single beam bathymetry, and multibeam bathymetry.

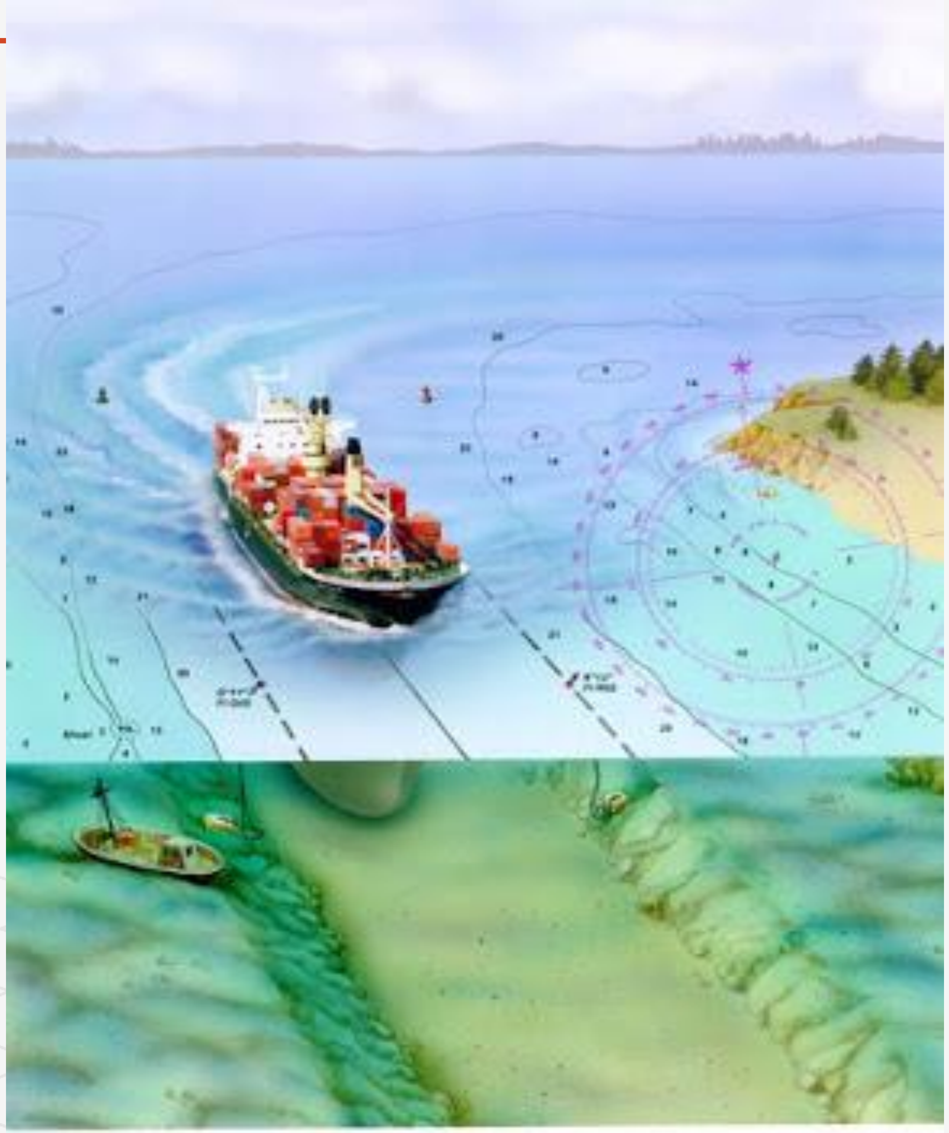
Modern multibeam sonars can record the complete trace from each beam, known as water column data, in addition to bottom detections.





Dredging





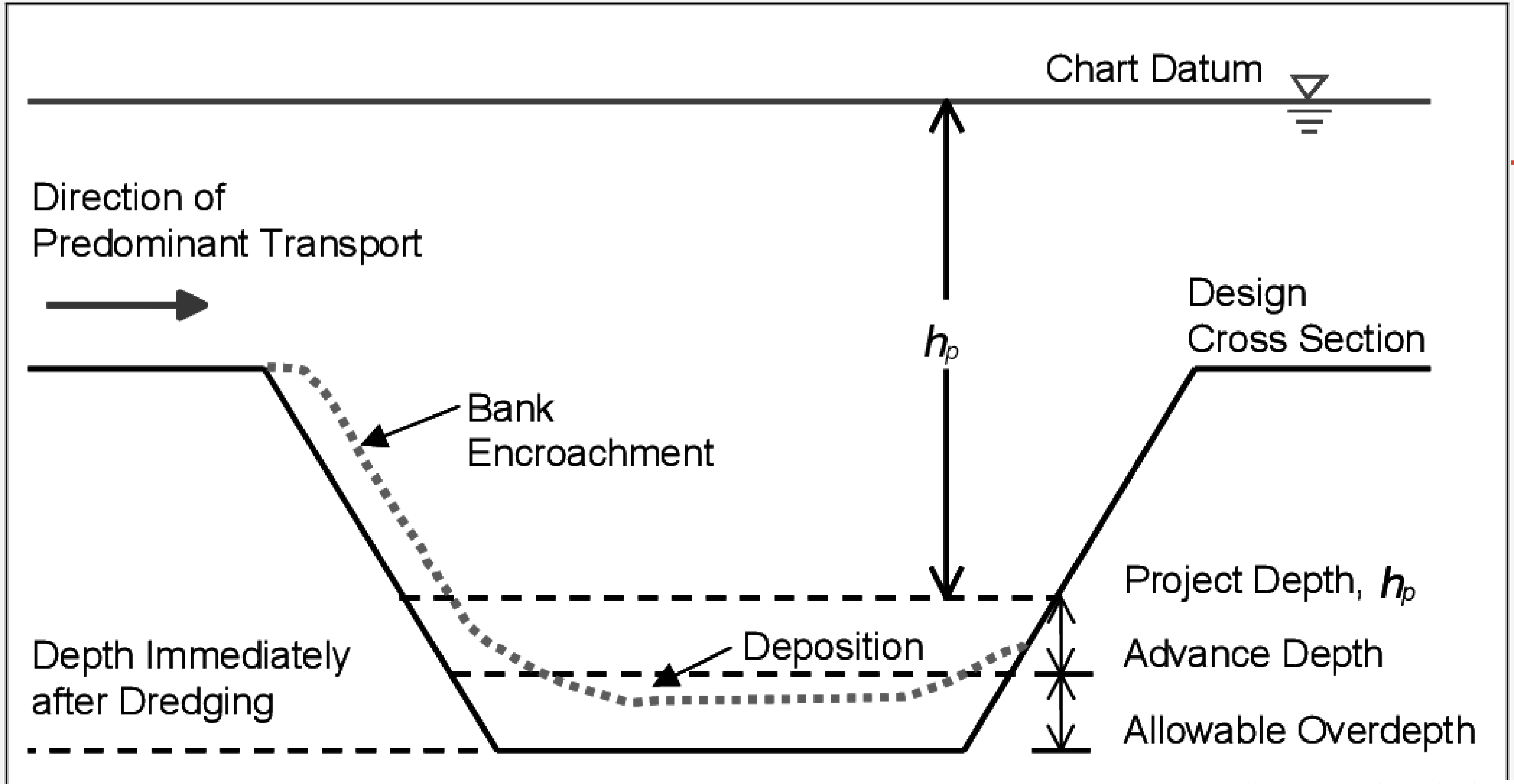
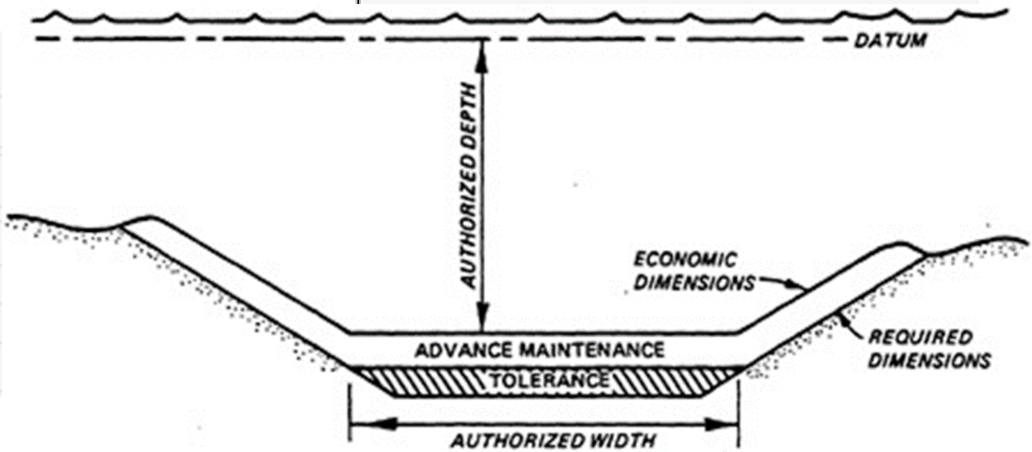


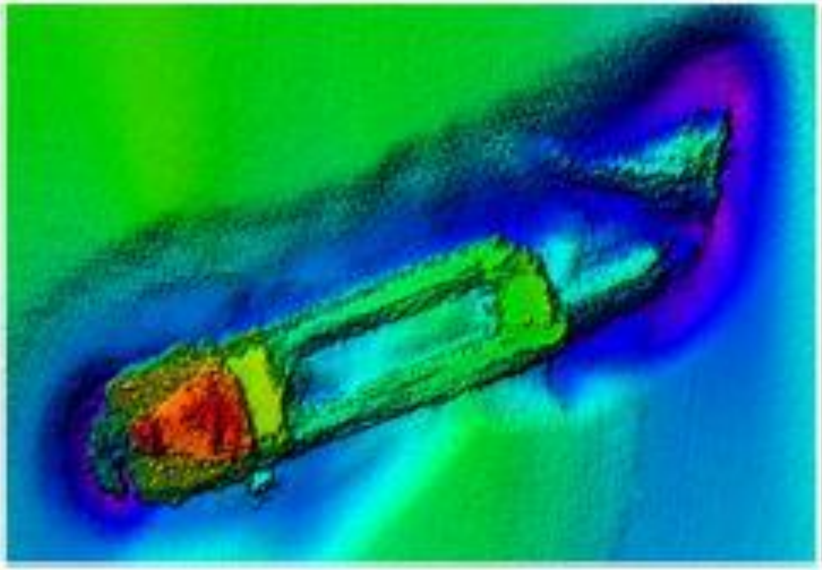
Chart Datum
Direction of Predominant Transport
h_p
Design Cross Section
Bank Encroachment
Project Depth, h_p
Deposition
Depth Immediately after Dredging
Advance Depth
Allowable Overdepth

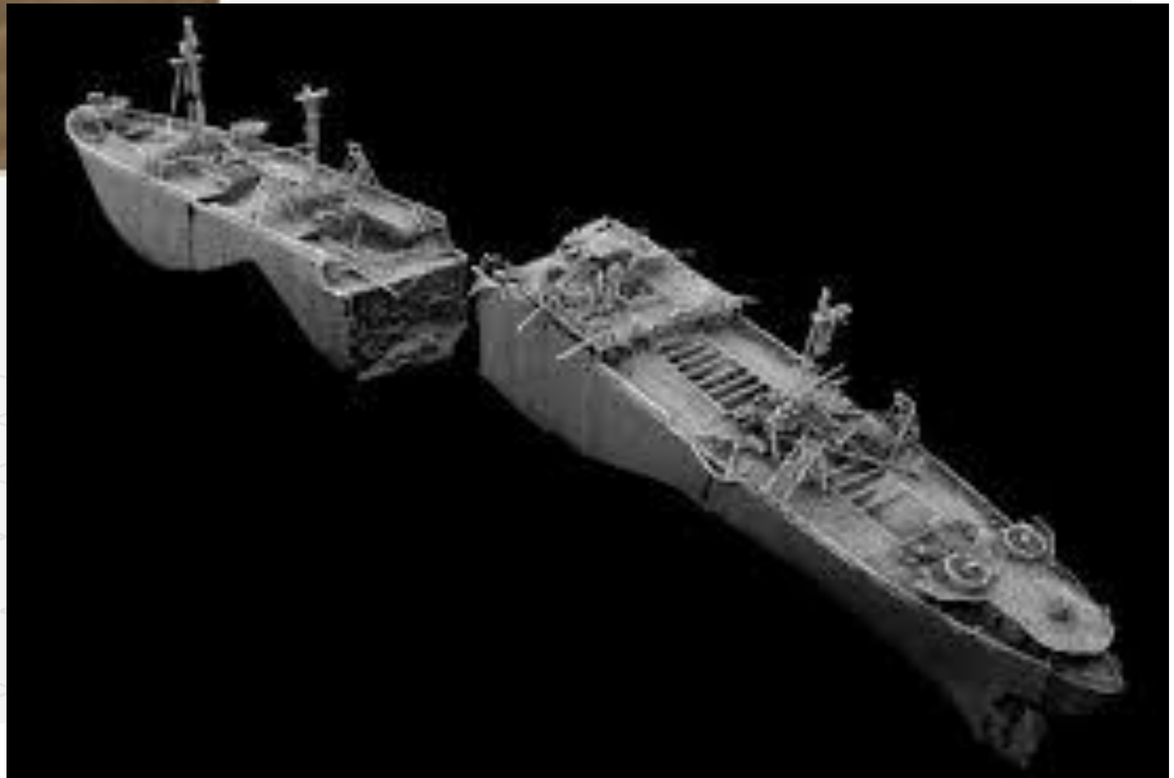

DATUM
AUTHORIZED DEPTH
ECONOMIC DIMENSIONS
REQUIRED DIMENSIONS
ADVANCE MAINTENANCE
TOLERANCE
AUTHORIZED WIDTH


HAM 318


HITACHI

Jabatan Warisan – monitor wreck





What is the purpose of hydrographic surveying? …..And where… sea or inland water…

Marine Department

Purpose Survey…

- Maintenance channel depth
- waterway planning
- dredging analysis
- wreck location
- Built new Beacon
- Safety of berthing jetty
- Search and rescue

Consultant.

- exploration/offshore oil drilling
- Sand Mining
- Plantation
- Marine aquaculture
- Wreck selvage
- Study purposes… High Learning

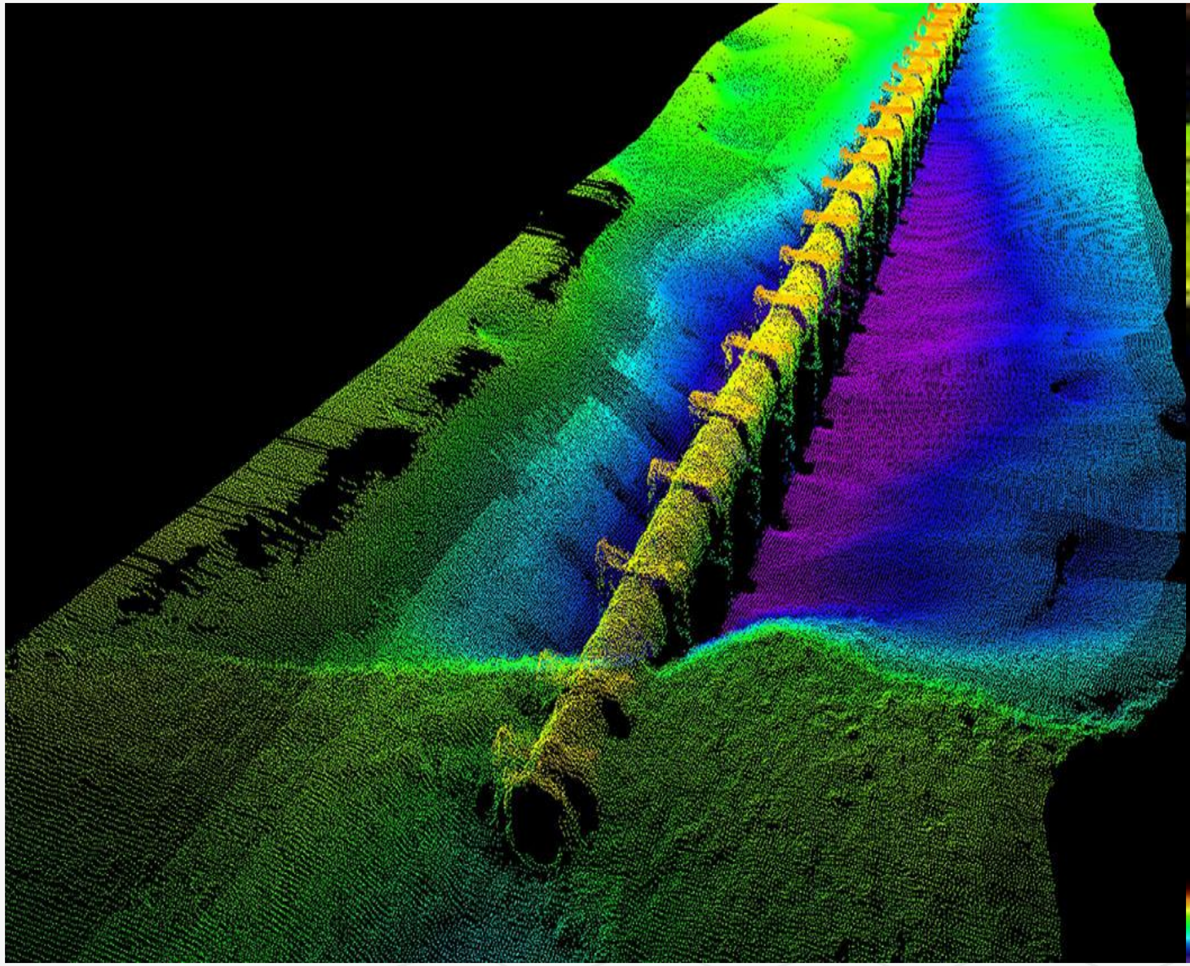
JKR

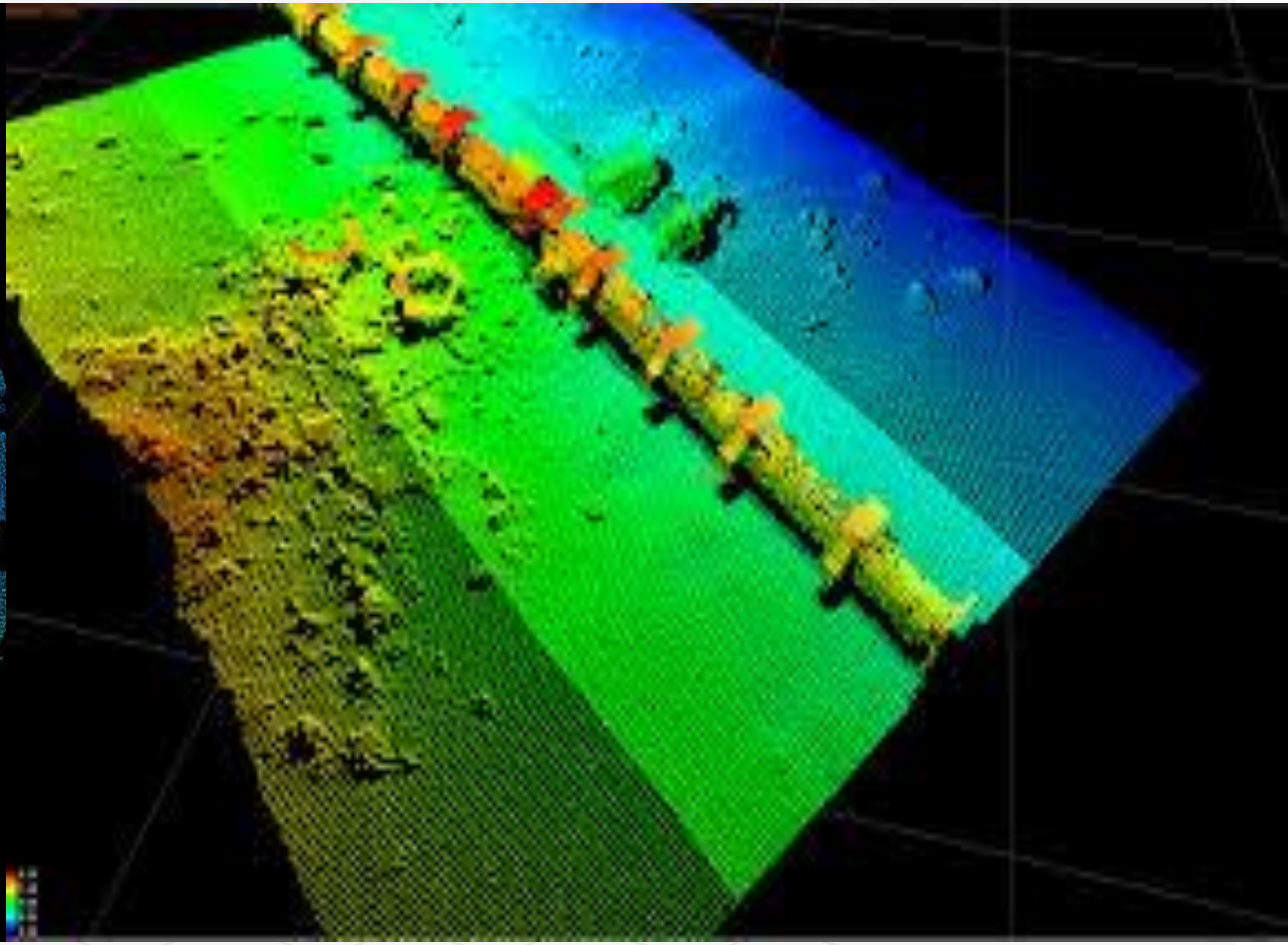
- . Constructions……..

JUPEM

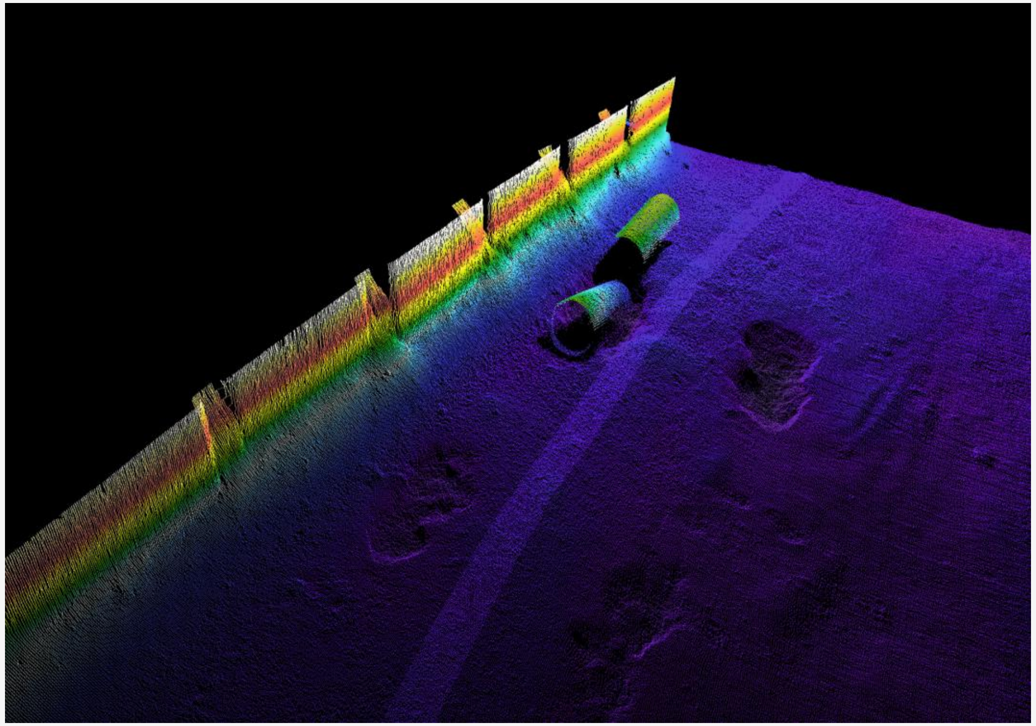
- State/international bounderies
- Baseline
- Setup new tidegauge station

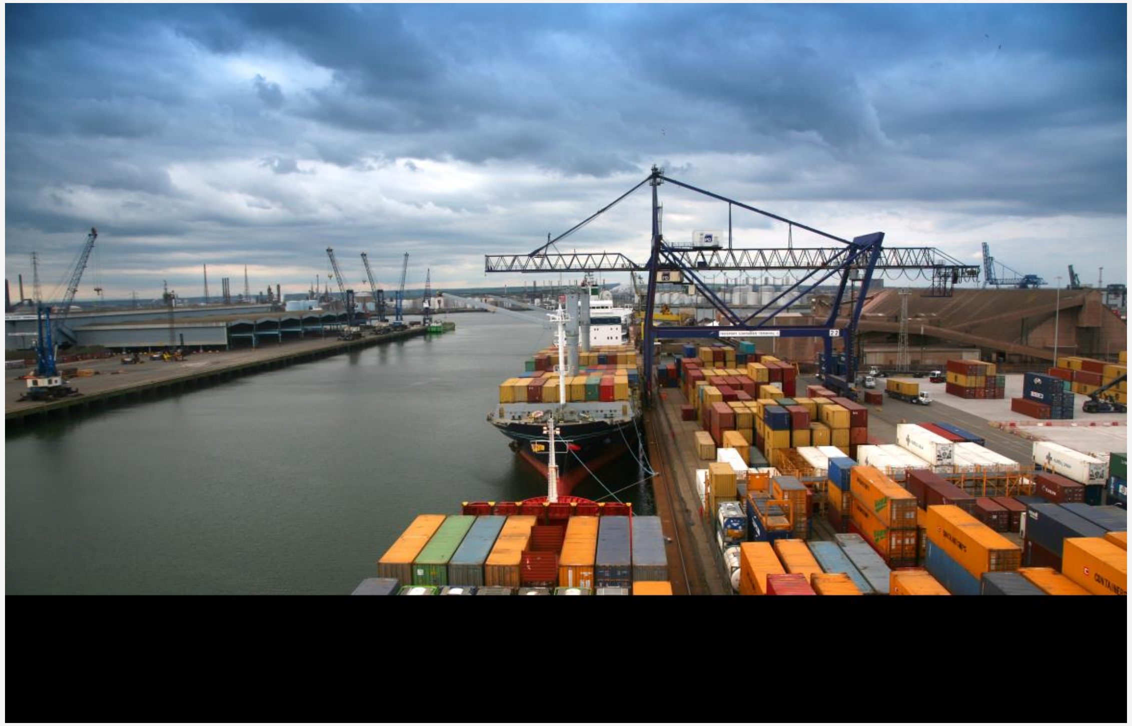
Offshore, coastal and inland water





Coastal Survey



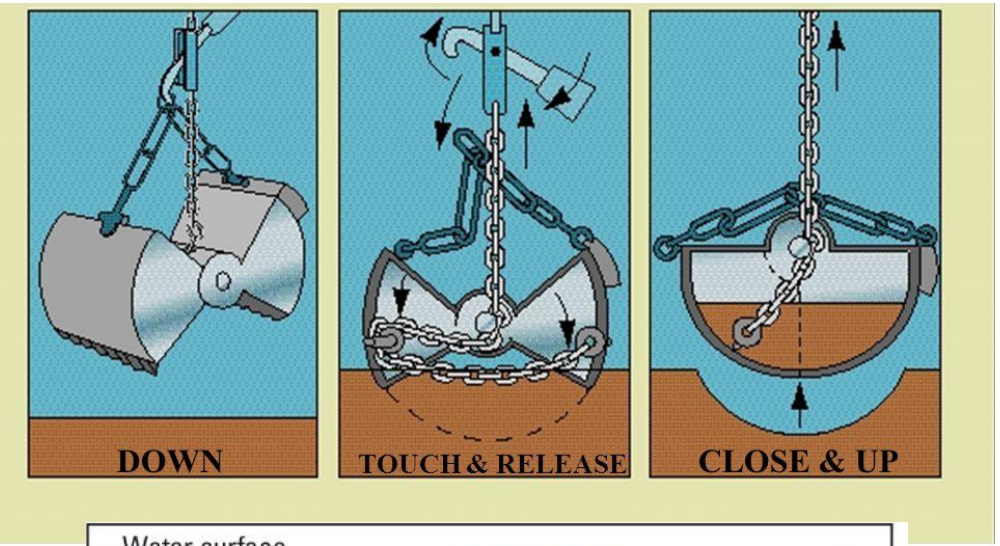


Port Survey : 100% check

JPS – coastal current and bottom sampling study purposes – erotion….

SAMPLING MARINE SURFACE SEDIMENTS

- **How a Van Veen-type grab sampler works**



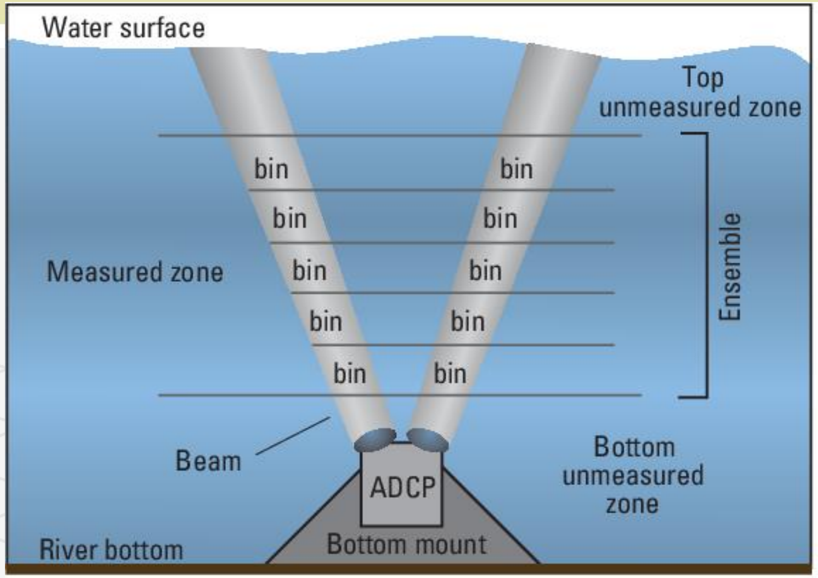


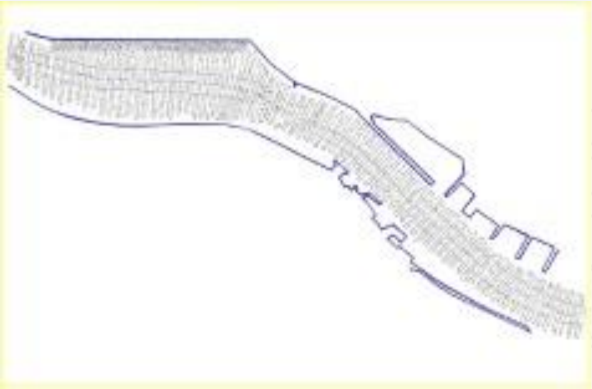
Figure 3. Schematic diagram of a bottom-mounted ADCP

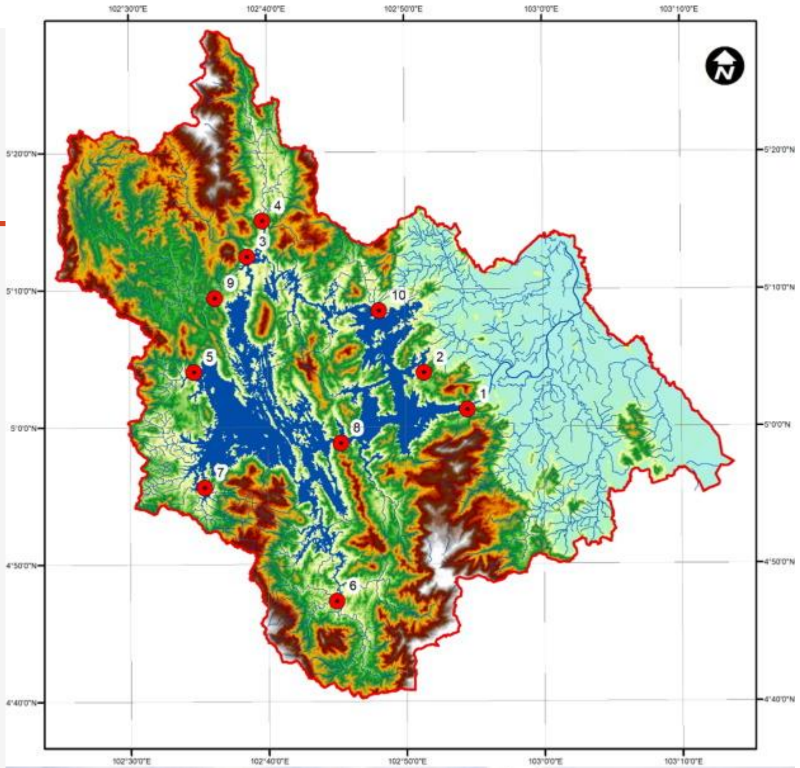
Current velocity measurements

Inland Water Mapping

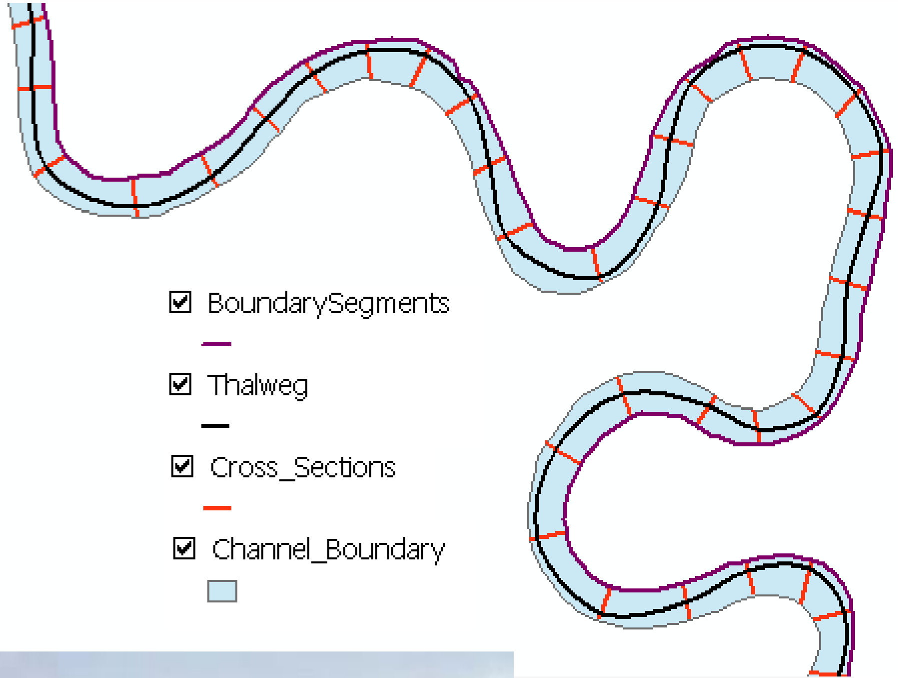
Even when for inland water mapping the hydrographic techniques are familar, there are special requirements and challenges often due to the specific characteristics of inland survey and positioning.

Bathymetric survey (rivers, ponds, dame lakes)

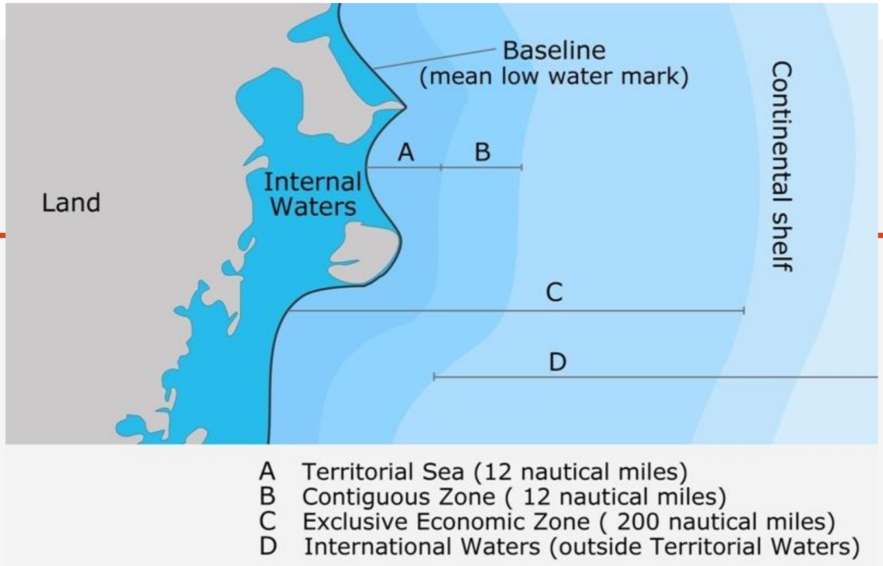




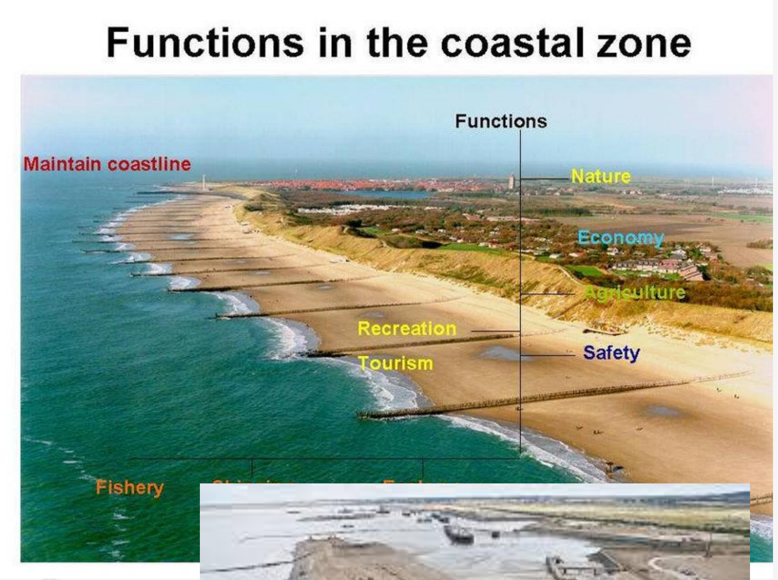
4. Inland water survey – reclamation
River (state boundry), lake (fish farming cage)



1. Coastal Survey -sea water in the internal waters and territorial sea zones



Management of Coastal Zone



River mouth and river, Sand mining, Land reclamation and dredging

Coastal Engineering, infrastructure project, jetties and port


MALAYSIAN COASTLINE
SEMENANJUNG MALAYSIA
(Length = 2031 km)
(Area = 131,590 km²)
SABAH
(Length = 1743 km)
(Area = 73,711 km²)
Laut China Selatan
Selat Melaka
SARAWAK
(Length = 1035 km)
(Area = 124,449 km²)
Summary of Coastline Length
Peninsular = 2,031 km
Sabah & Sarawak = 2,778 km
Total length = 4,809 km


Coastal Sediments
Legend
Mud
Sand
Stone


Coastal Sediment
Legend
Mud
Sand
Stone

Coastal Zone Management:

Coastal Zone Management: Hydrographic surveys provide data for coastal hazards and vulnerability assessment of coastal landscapes in relation to climate change, subsidence, glacial rebound, and others. Bathymetric data provide ancillary information on indicators that capture the biophysical conditions and morphodynamic classification.

Coastal Geomorphology:

Coastal Geomorphology: Hydrographic surveys provide data for morphodynamic classification of coastal areas from sea state (breaking wave heights), bathymetry, tide regimes (F-factor computed from tide constituents).

Beach

- Actively changing
- Shore: backshore, foreshore, nearshore, offshore
- Berm, beach face, longshore bar, longshore trough

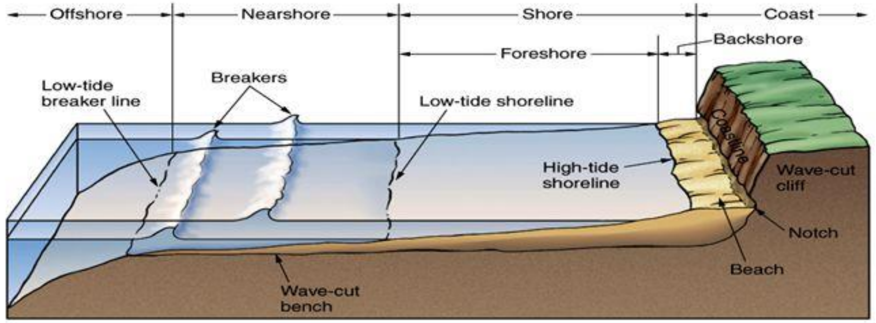
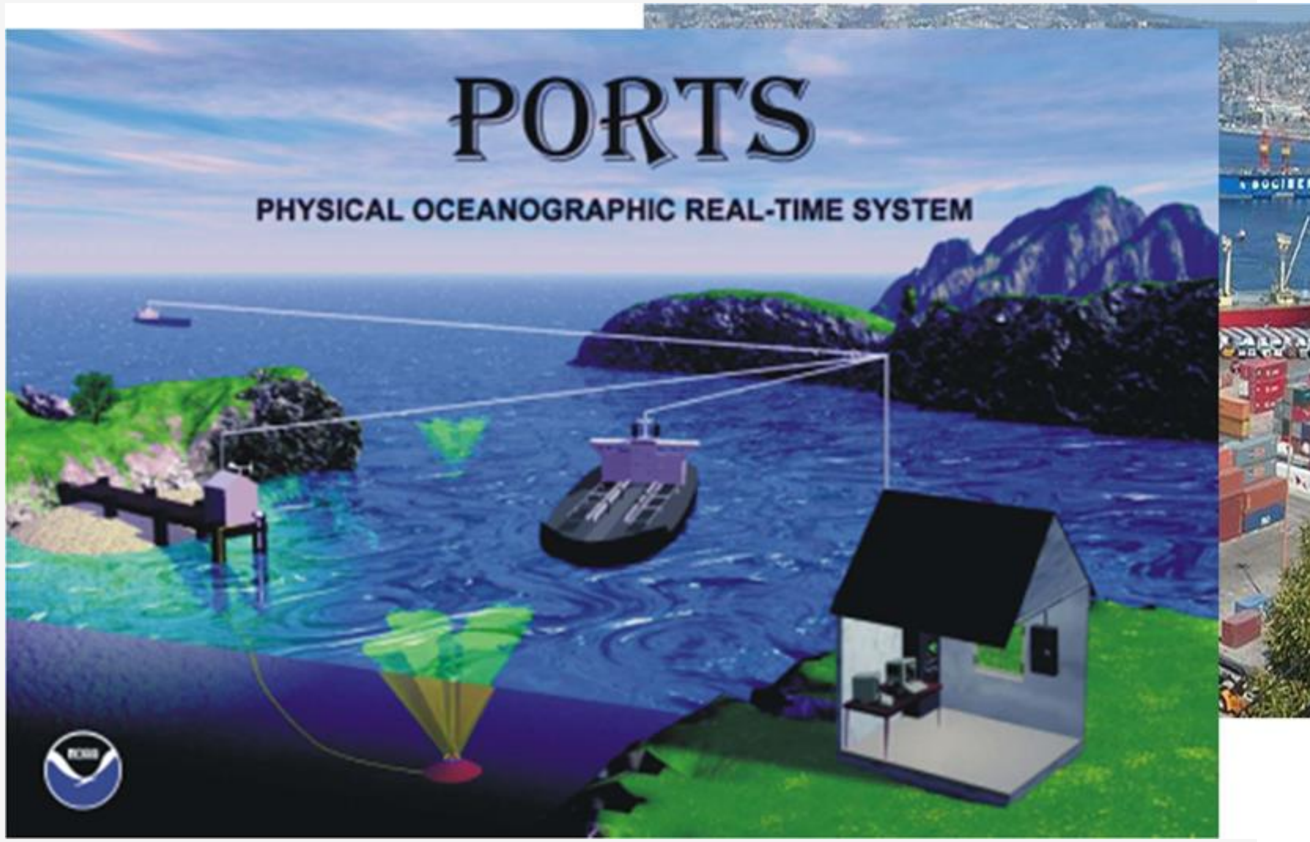


Fig. 11-1

Port and Harbor Operations

Port and Harbor Operations: Survey data are required for effective management of water resources and harbor estuaries. Operations include maintenance dredging, debris removal for clear passage of vessels, environmental restoration, marine structural design, and many others.

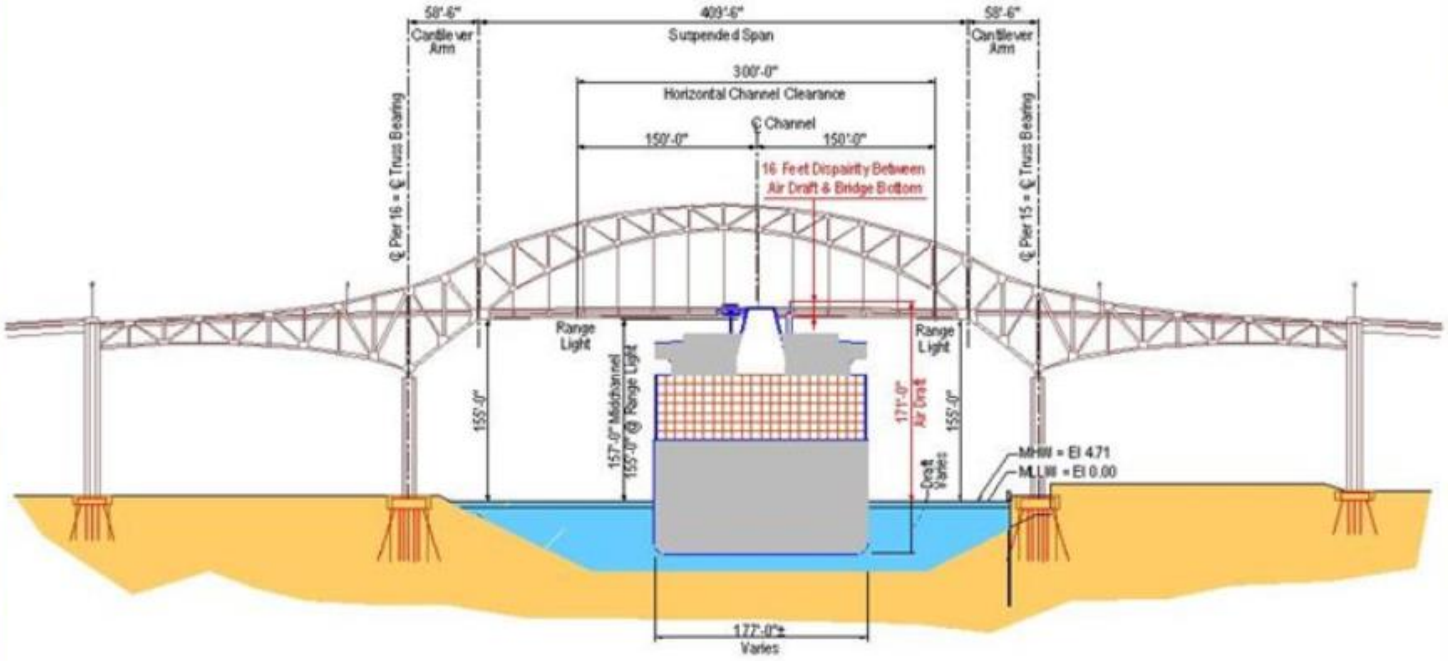
- Modern nautical charts are required for safe navigation along coasts and to enter its ports. A lack of adequate nautical charts prevents the development of maritime trade in the waters and ports of the concerned nations.
- Observations and Forecasts of Water Levels, Tides & Currents Used by the mariner to inform decisions for safe navigation and efficiency – to make sound decisions regarding the off-loading and on-loading of materials, and ship movement along the coast.



coastal engineering (beach erosion and replenishment studies)

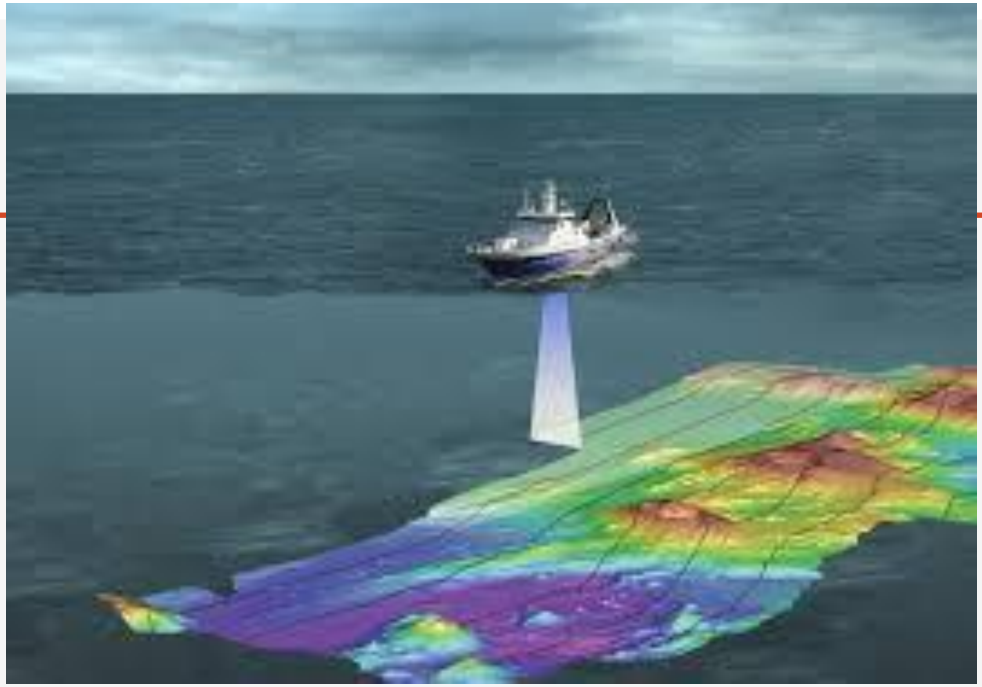
Coastal Engineering: Coastal mapping data is required for civil works projects such as revetments, jetties, and beach nourishments. Hydrographic survey data is used to understand various processes that shape the coastlines and human interaction with these processes.

Bridge construction – UKC & Height Clearance



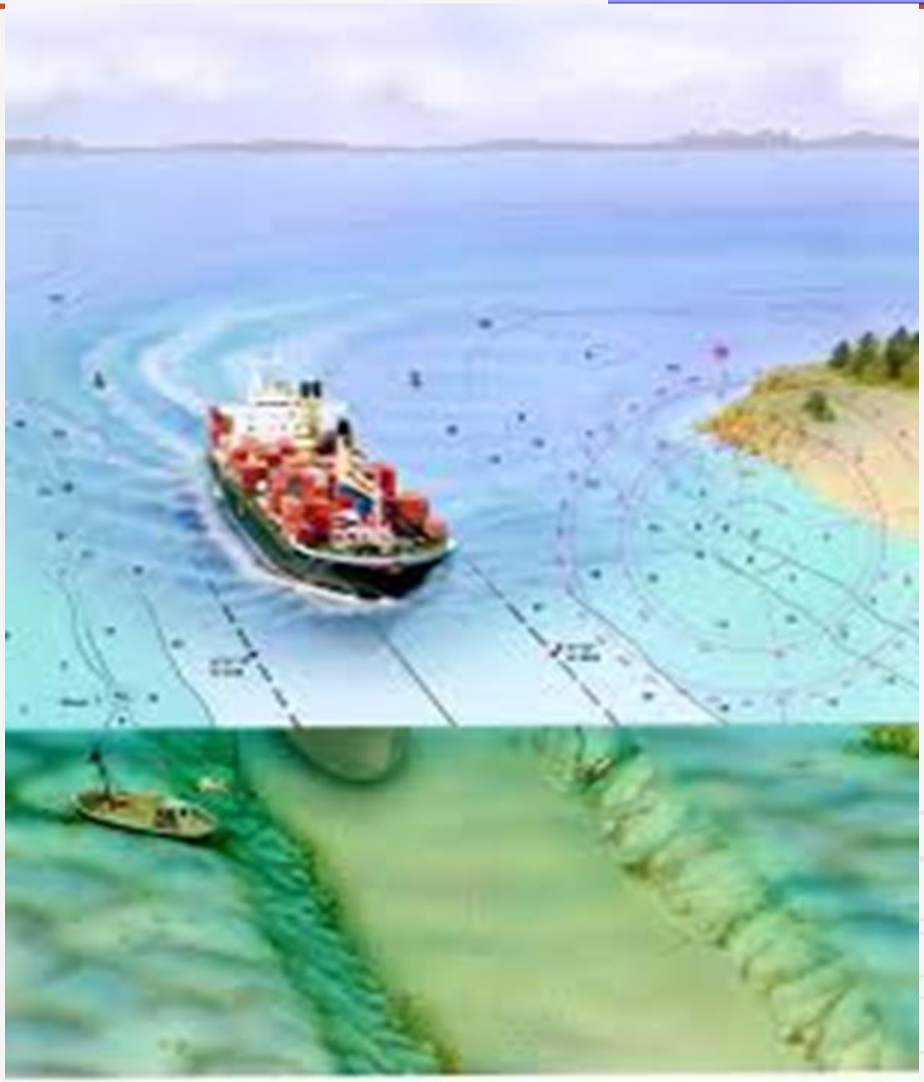
Ships now are limited by height, draft, and width of channel.

2. Off-shore Survey
nautical charting, , cable and piping laying

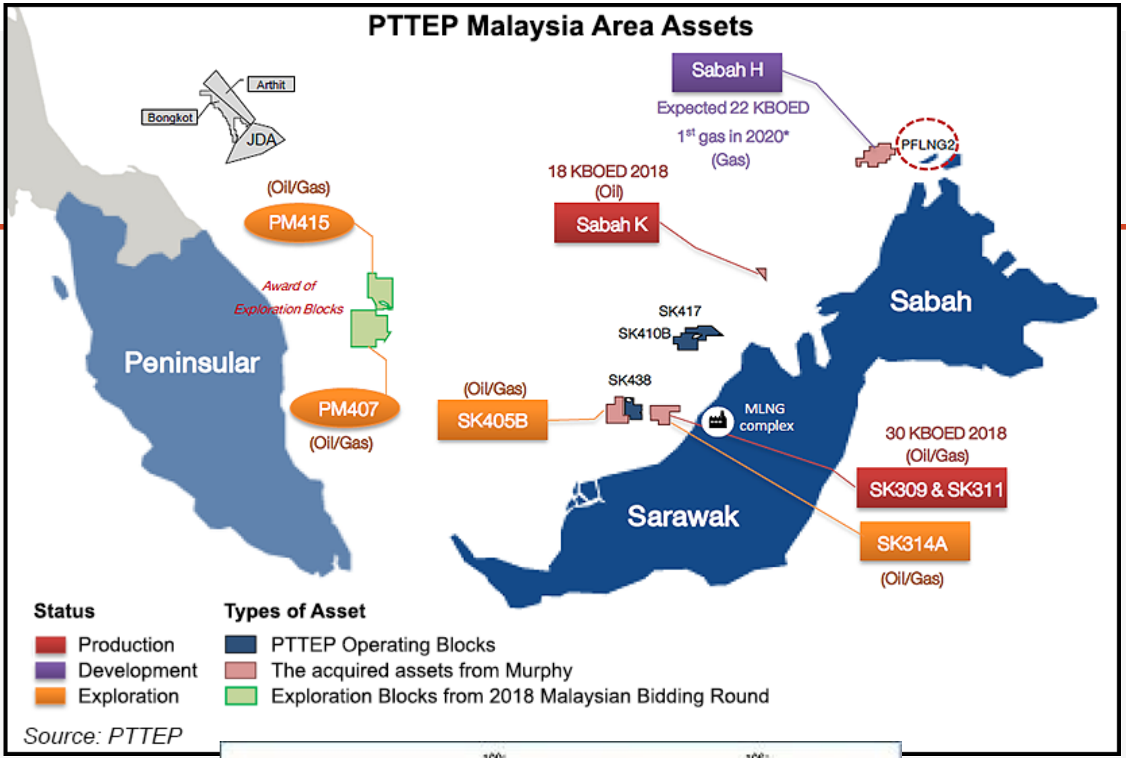


Nautical Charting

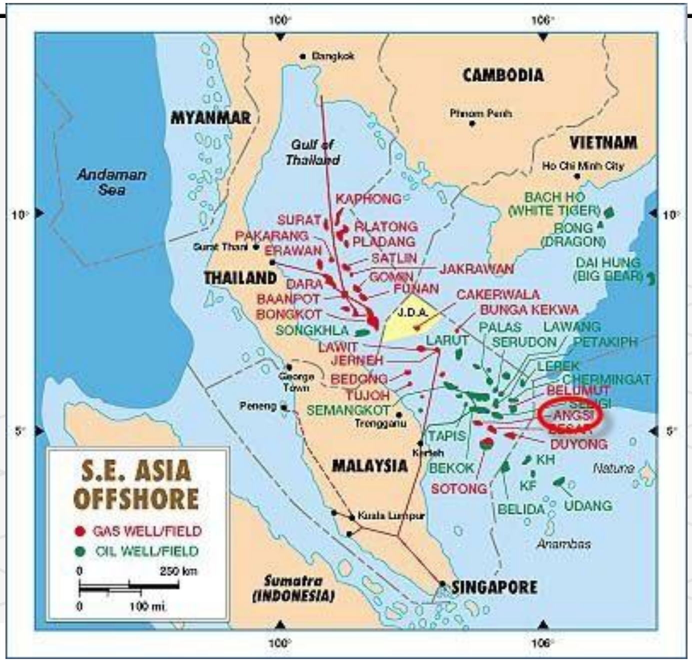
Size of vessels



Offshore Resource Mapping:



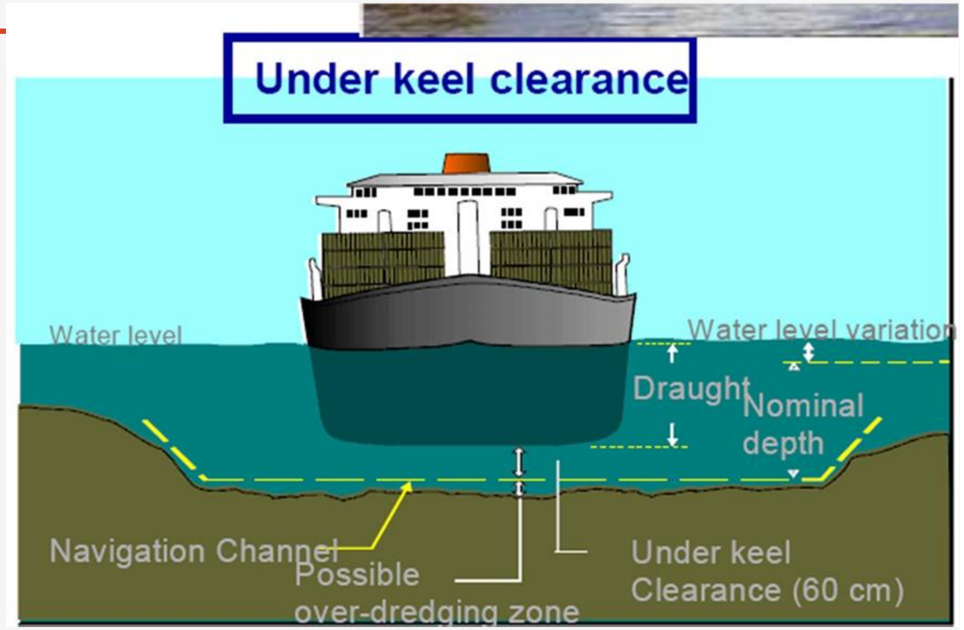
Offshore Resource Mapping: Offshore energy resources include wind, wave, and geologic mineral (oil, natural gas etc) deposits. Surveys and Geographic Information Systems are invaluable tools to identify the exploitation of these energy resources.



234,006 GT

162,477 NT
441,585 DWT
Displacement:
67,829 long tons (68,917 t) light
509,484 long tons (517,660 t) full load

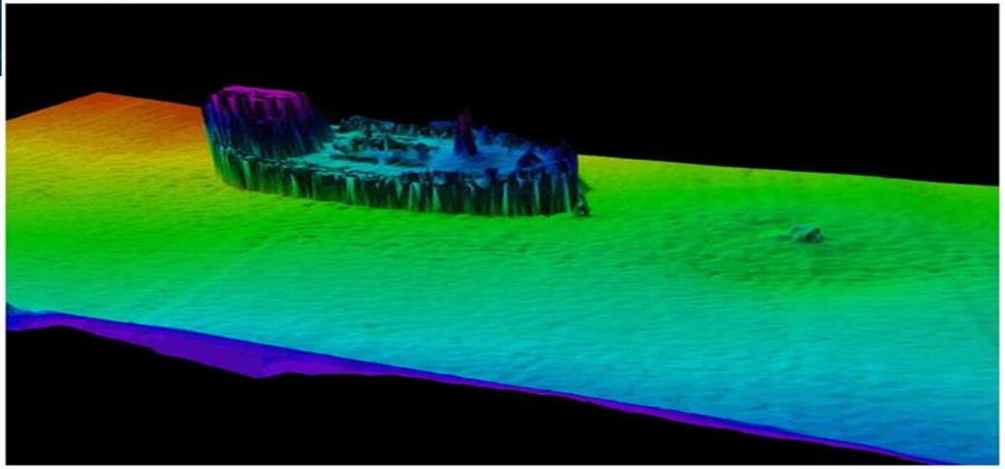
Length:	380 m (1,246 ft 9 in) o/a
Beam:	68 m (223 ft 1 in)
Draught:	24.5 m (80 ft 5 in)
Speed:	16.5 knots (30.6 km/h; 19.0 mph) (laden)
Capacity:	3,166,353 barrels (503,409,900 L)



- The navigation of commercial vessels requires accurate knowledge of water depth in order to exploit maximum cargo capabilities safely, especially in critical areas of marginal under-keel clearence and where the possibility of obstruction exists.

- More than 80% of international trade in the world is carried by sea. Maritime commerce is a basic element for a nation's economy.

- Charts, produced by means of modern hydrographic surveys, are required to enable the larger ships of today to navigate through national waters and enter ports, the access to which was formerly insecure. They are essential tools for the creation of coastal nations'

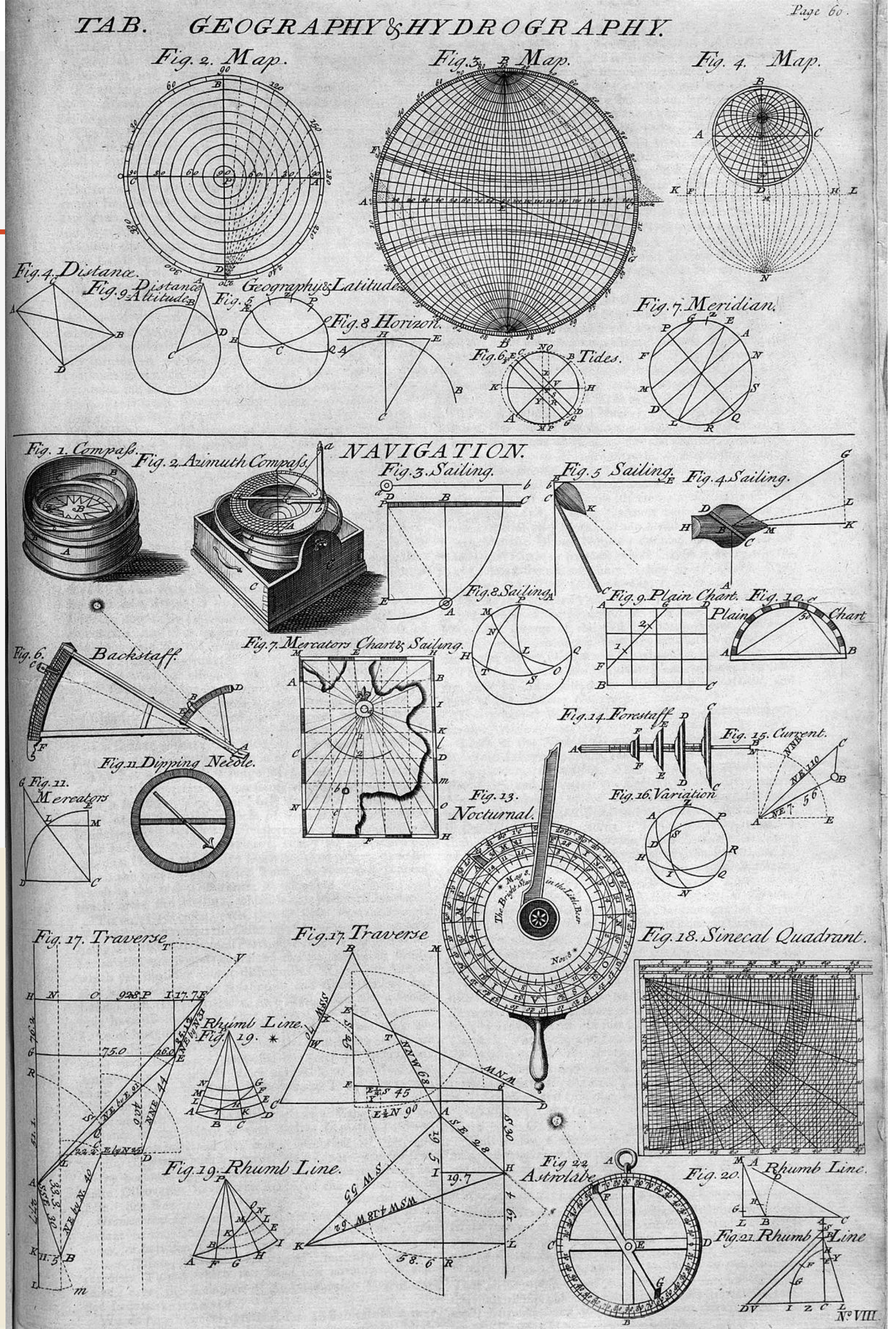


In UK waters alone, the database holds over 29,000 wrecks, worldwide this number rises to over 69,000 losses increasing by an average of 100 a month, according to Lloyds Register of Shipping.

Principal of Hydrography

IHO

International
Hydrographic
Organization



Competency Certificate- IHO

INTERNATIONAL FEDERATION OF SURVEYORS | **INTERNATIONAL HYDROGRAPHIC ORGANIZATION** | **INTERNATIONAL CARTOGRAPHIC ASSOCIATION**

GUIDELINES FOR THE IMPLEMENTATION OF THE STANDARDS OF COMPETENCE FOR HYDROGRAPHIC SURVEYORS

Hydro I, Hydro II (Cat A) and Hydro III (Cat A for LS)

UTM HYDRO I (HYDROGRAPHIC SURVEYING I PROGRAMME)
FIG/IHO/ICA CATEGORY B

17 September 2018 - 14 March 2019

ORGANISED BY
Centre for Hydrographic Studies (CHS)
Faculty of Built Environment and Surveying
Universiti Teknologi Malaysia (UTM)

RECOGNISED BY

SUPPORTED BY

Competency

Category A – Hydro I

Category B – Hydro II

Category A – Hydro III – Special for License Surveyor

The Standards are maintained by FIG, IHO and ICA

The International Board for Standards of Competences

10 members from parent organisations (4 FIG, 4 IHO and 2 ICA),

• Governemental, educational and civil sector;

• Experienced professionals in education, hydrography and cartography, from various areas of the world (Australia, Brazil,France, Caribbean, Greece, Indonesia, New Zealand, UK, USA)

Rationale for category A and category B separation (1)

Cat A:

• **Project leader** :
design, plan, choose appropriate technology, select and supervise a survey team

• Should be familiar with underlying physics and mathematics of survey or cartographic works

• Able to evaluate survey or cartographic product against initial expectations

• In the navy : hydrographer in charge of a major survey unit

• In the industry: lead hydrographer or chief surveyor of a major project

Cat A standards will be aimed at *theoretical educational and*

foundational background necessary for Hydrographers/Nautical Cartographers-In-Charge and hydrographic/cartographic managers who will

- Develop specifications for surveys and charts;
- establish quality control and quality assurance systems;
- respond to the specific requirements of a full range of hydrographic/ cartographic projects.

Category B:

- **Watchleader** : reports to a category A project leader

- Should be familiar with fundementals and practical aspects of hydrographic surveying and/or cartographic works

- In the Navy : junior officer in charge of a survey launch

- In the Industry: team leader in charge of localized surveys Standards will be aimed at the *Basic educational level and training of survey technicians*

. Subjects in Standards of Competence for Hydrographic Surveyors.

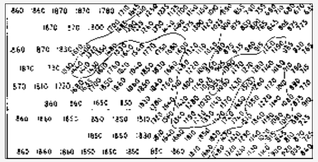
S-5A Subjects	S-5B Subjects
B1 Mathematics, statistics, theory of observations B2 Information and Communication Technology B3 Physics B4 Nautical science B5 Meteorology	B1 Mathematics, Statistics, Theory of Errors B2 Information and Communication Technology B3 Physics B4 Earth Sciences B5 Nautical science B6 Meteorology
F1 Earth Models F2 Oceanography F3 Geology and geophysics	E1 Underwater Acoustics E2 Remote Sensing E3 Water Levels And Flow E4 Positioning E5 Hydrographic Practice E6 Hydrographic Data Management E7 Environment
H1 Positioning H2 Underwater Sensors and Data Processing H3 LiDAR and Remote Sensing H4 Survey Operations and Applications H5 Water Levels and Flow H6 Hydrographic Data Acquisition and Processing H7 Management of Hydrographic Data H8 Legal Aspects	COMPREHENSIVE FINAL FIELD PROJECT
COMPLEX MULTIDISCIPLINARY FIELD PROJECT	

2. Hydrographic Practice

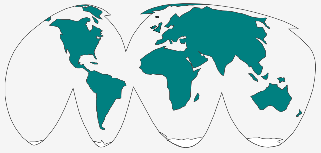
Disciplines Associated with Hydrographic Surveying

Disciplines Associated with Hydrographic Surveying

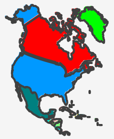
Hydrography relies on a variety of scientific and engineering disciplines. Figure below illustrates the core disciplines like Geodesy, Photogrammetry, Cartography, Global Positioning System, Oceanography, Tides, Physics and Mathematics. These are the various disciplines that influence the science and products delivered by hydrographic survey.



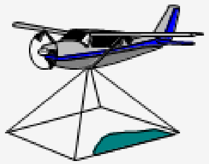
Hydrography



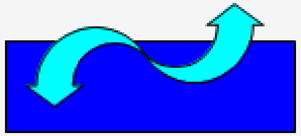
Geodesy



Cartography

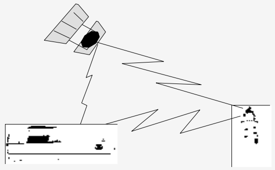


Photogrammetry

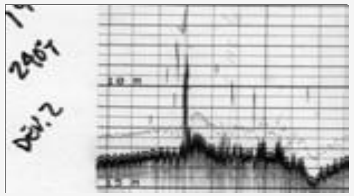


Oceanography

Tides



Global Positioning System



Acoustics

Disciplines that Influence the Science of Hydrography

Survey Planning and reconnaissance

Logistic preperation and Authority approval

Reconnaissance

As every project require a start-up plan to complete it effectively and economically, reconnaissance has to be undergone. A complete reconnaissance of whole survey area to choose the best way of performing the survey. This would facilitate satisfactory completion of the survey in accordance with the requirements and specifications governing such work. Aerial photographs would help this study.

Locating Horizontal Control

The horizontal control is necessary to locate all features of the land and marine in true relative positions. Hence a series of lines whose lengths and azimuths are determined by means of either triangulation or any other methods. Tachometric and plane table survey can be conducted in order to undergo rough works. No rules are kept for establishing horizontal control as topography, vegetation, type, size of topography affect the rules.

Locating Vertical Control

Before sounding establishment of vertical control is essential to determined. Numerous benchmarks are placed in order to serve as vertical control. Setting and checking the levels of the gauges are uses of benchmarks

Survey Standards - S-44

S-44 edition 5

The IHO's New Standard For Hydrographic Surveys

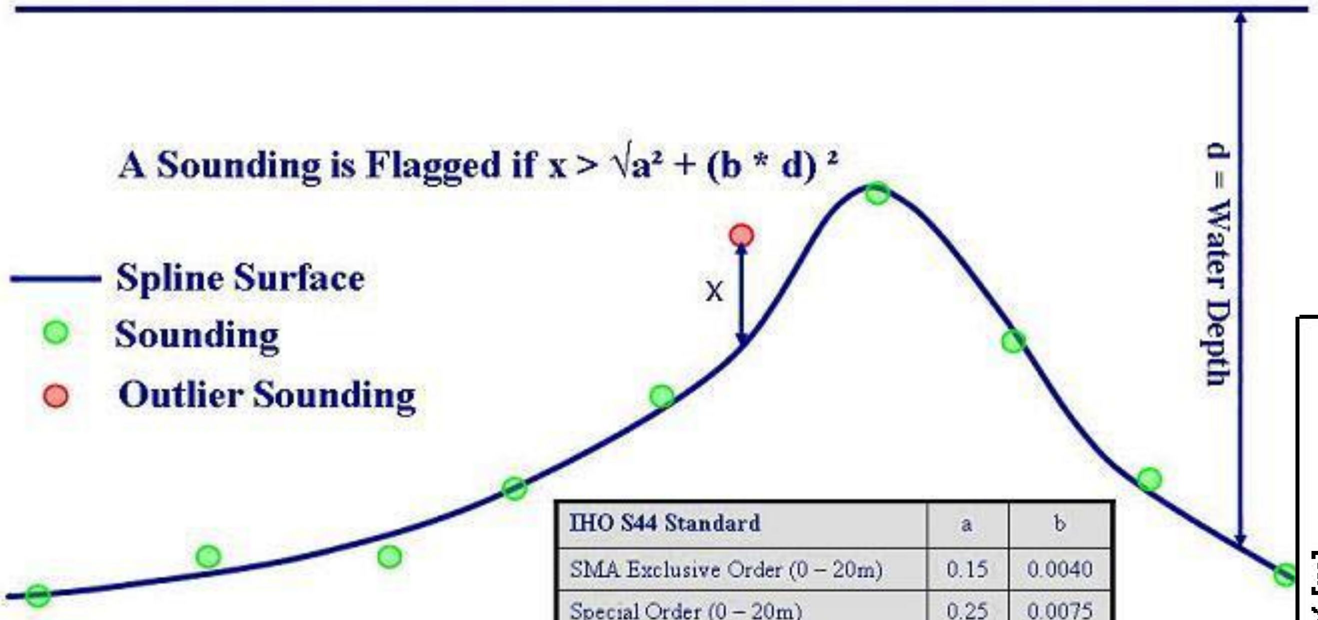
S-44 edition 5

The IHO's New Standard For Hydrographic Surveys

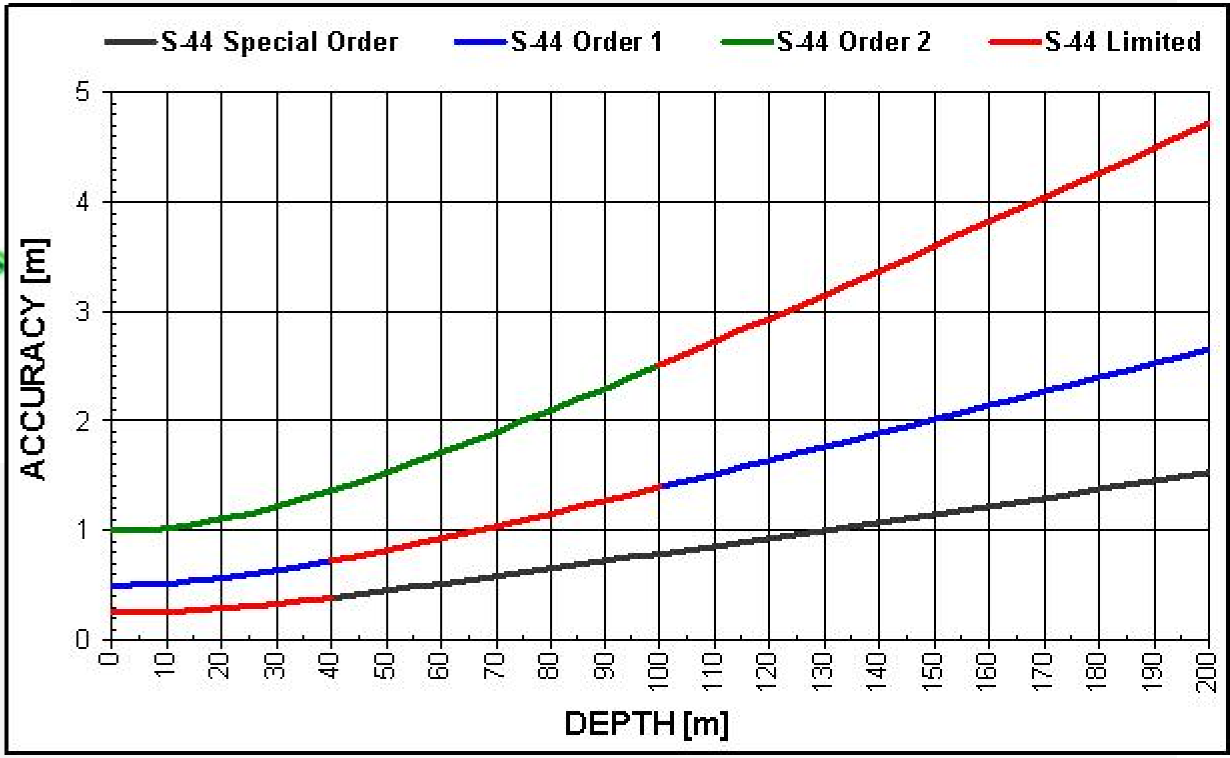
IHO Categories (IHO Standards for Hydrographic Surveys 5th Edition, February 2008. Special Publication No. 44.

Reference	Order	Special	1a	1b	2
Chapter 1	Description of areas.	Areas where under-keel clearance is critical	Areas shallower than 100 metres where under-keel clearance is less critical but features of concern to surface shipping may exist.	Areas shallower than 100 metres where under-keel clearance is not considered to be an issue for the type of surface shipping expected to transit the area.	Areas generally deeper than 100 metres where a general description of the sea floor is considered adequate.
Chapter 2	Maximum allowable THU 95% Confidence level	2 metres	5 metres + 5% of depth	5 metres + 5% of depth	20 metres + 10% of depth
Para 3.2 and note 1	Maximum allowable TVU 95% Confidence level	a = 0.25 metre b = 0.0075	a = 0.5 metre b = 0.013	a = 0.5 metre b = 0.013	a = 1.0 metre b = 0.023
Glossary and note 2	Full Sea floor Search	Required	Required	Not required	Not required
Para 2.1 Para 3.4 Para 3.5 and note 3	Feature Detection	Cubic features > 1 metre	Cubic features > 2 metres, in depths up to 40 metres; 10% of depth beyond 40 metres	Not Applicable	Not Applicable
Para 3.6 and note 4	Recommended maximum Line Spacing	Not defined as full sea floor search is required	Not defined as full sea floor search is required	3 x average depth or 25 metres, whichever is greater For bathymetric lidar a spot spacing of 5 x 5 metres	4 x average depth
Chapter 2 and note 5	Positioning of fixed aids to navigation and topography significant to navigation. (95% Confidence level)	2 metres	2 metres	2 metres	5 metres
Chapter 2 and note 5	Positioning of the Coastline and topography less significant to navigation (95% Confidence level)	10 metres	20 metres	20 metres	20 metres
Chapter 2 and note 5	Mean position of floating aids to navigation (95% Confidence level)	10 metres	10 metres	10 metres	20 metres

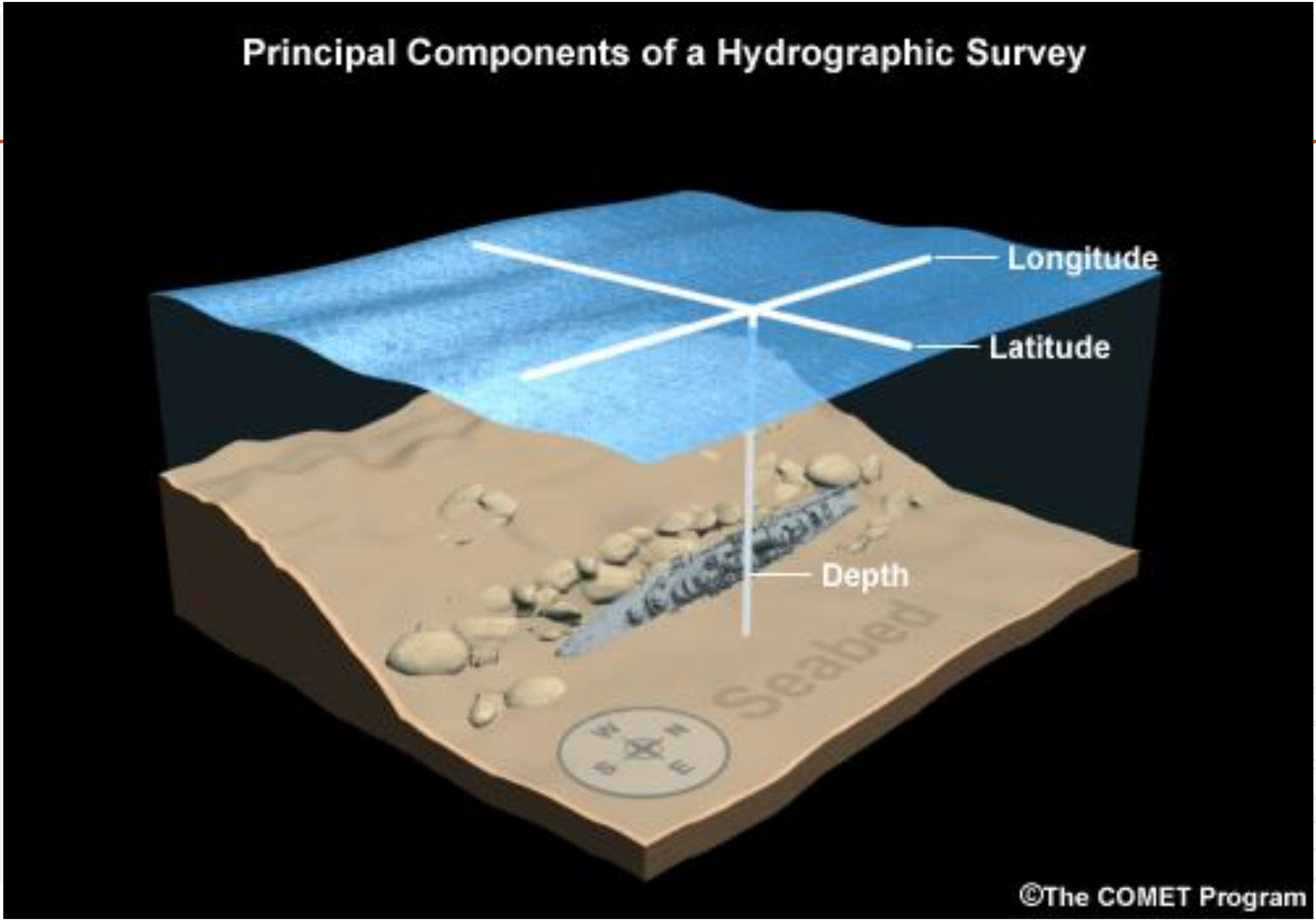
IHO S44 Guidelines for Outlier Detection



IHO S44 Standard	a	b
SMA Exclusive Order (0 – 20m)	0.15	0.0040
Special Order (0 – 20m)	0.25	0.0075
First Order (20 – 50m)	0.50	0.0130
Second Order (50 – 100m)	1.00	0.0230
Extremely High Detail (0 – 10m)	0.05	0.0020



Geodetic Control and Tidal Effects


Principal Components of a Hydrographic Survey
Longitude
Latitude
Depth
Seabed
©The COMET Program

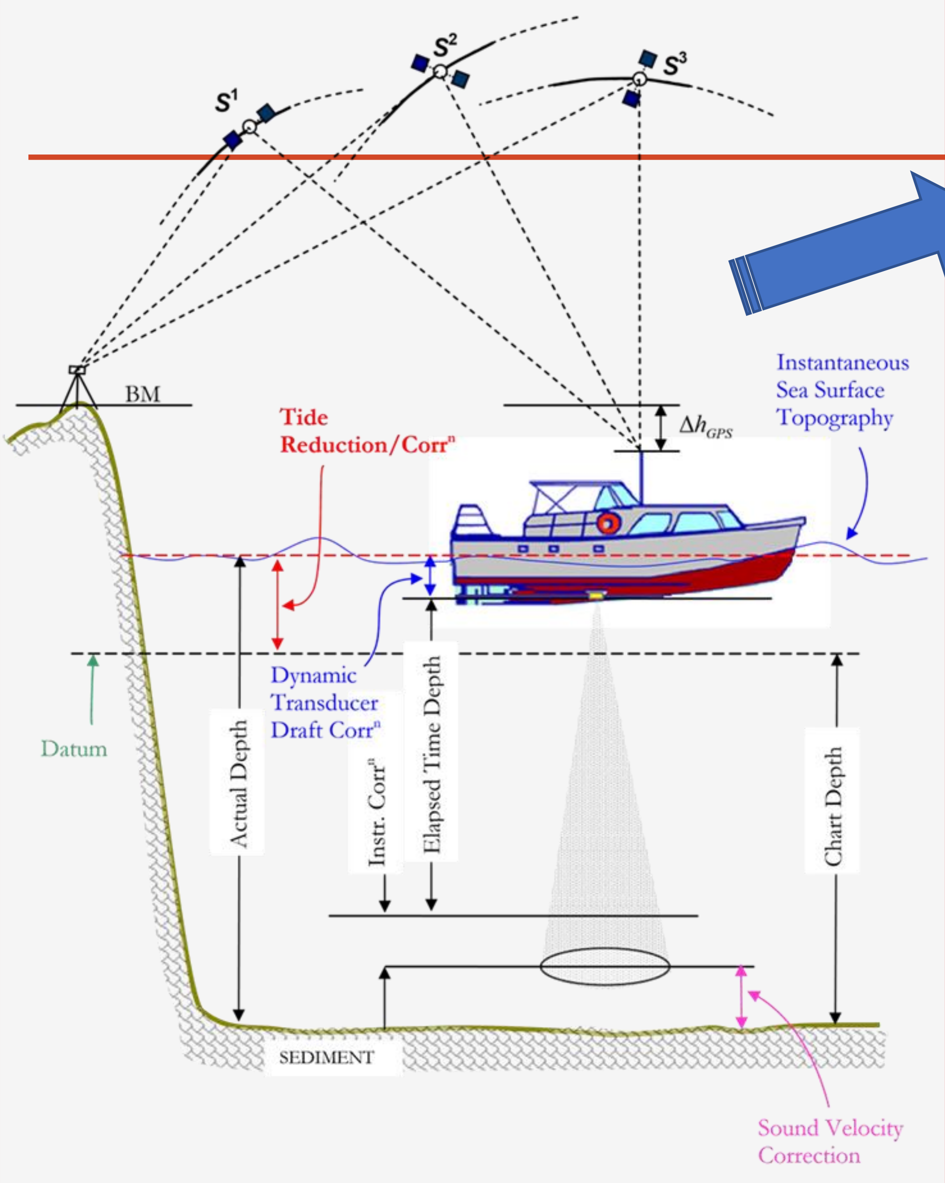
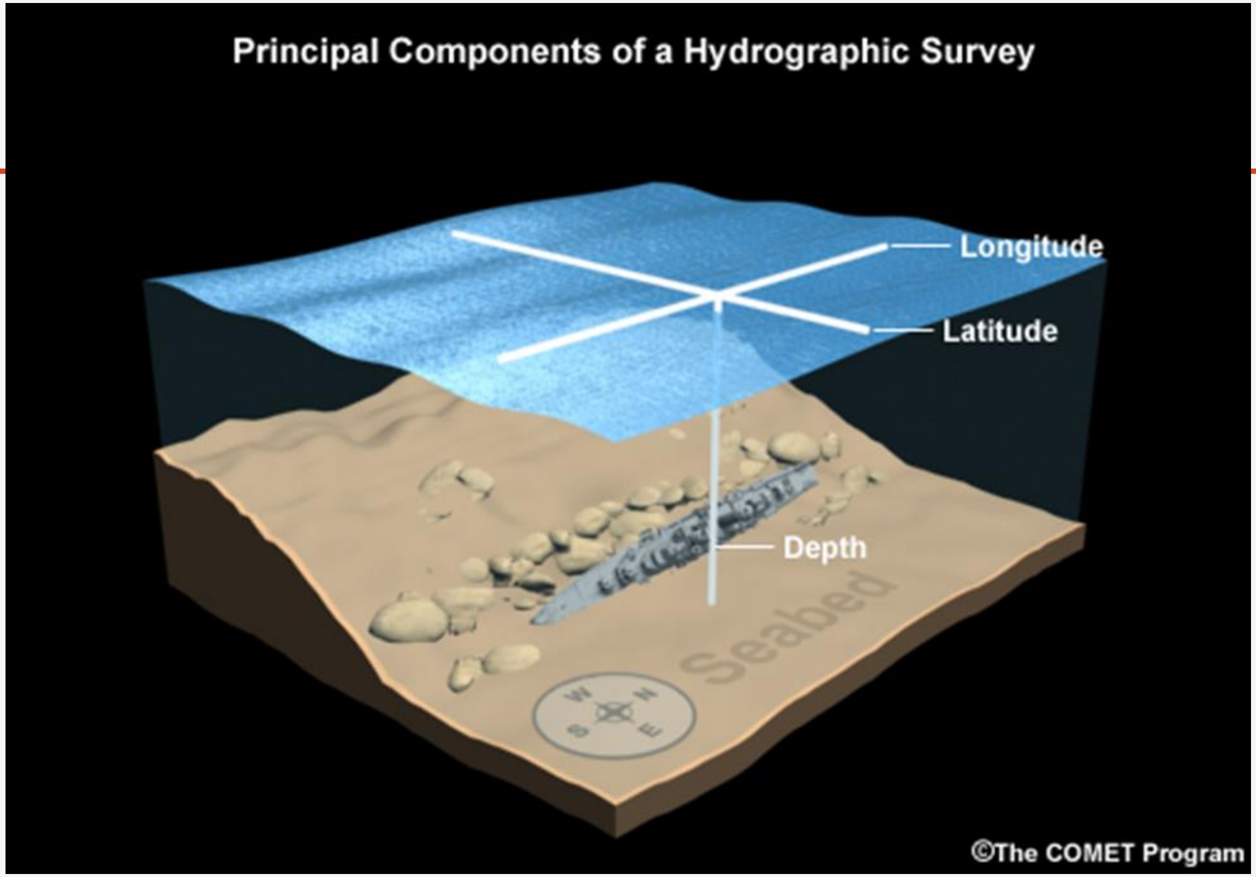


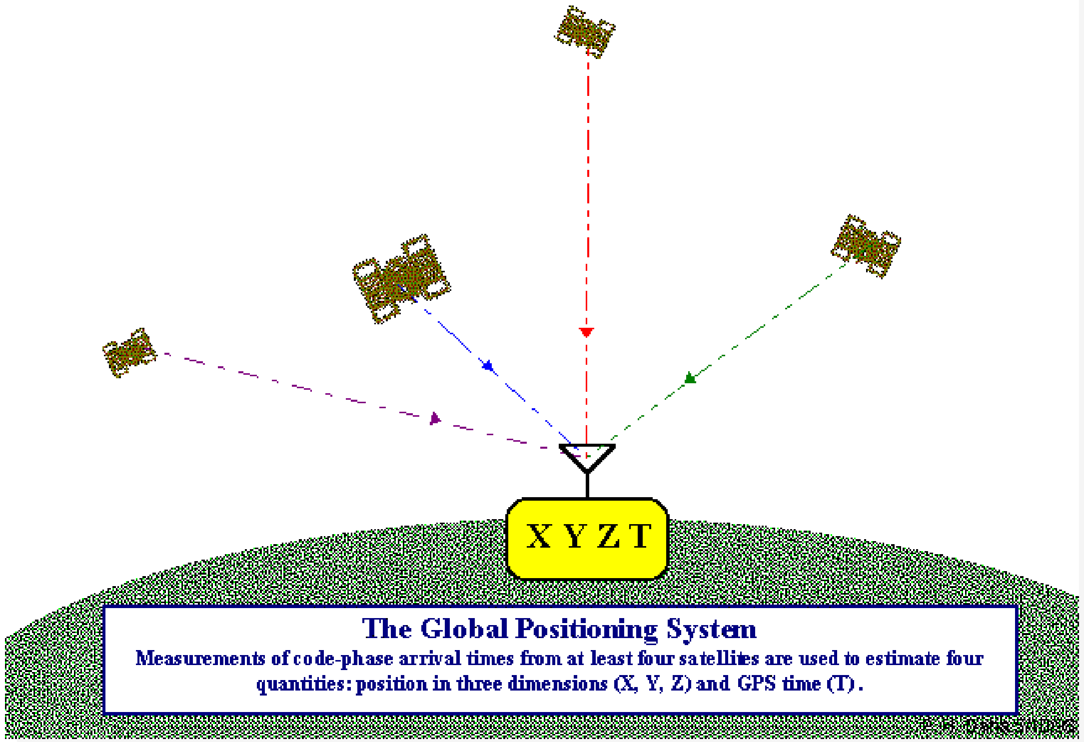
Figure 3.3: Acoustic Hydrographic Survey



Contributions of X, Y, Z and T

- coordinate (POSITION) X, Y
- Height (Depth) Z
- Time T

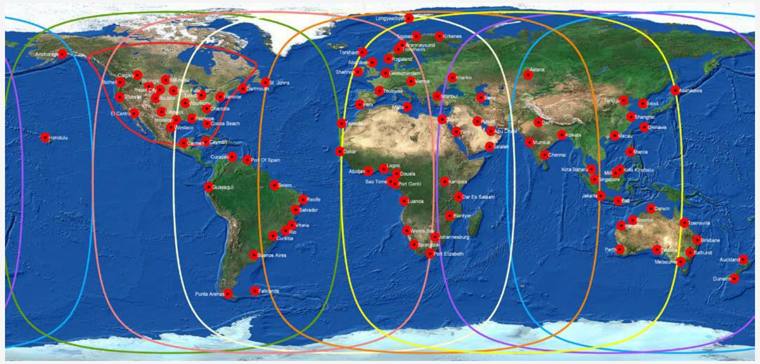
Coordinate (POSITION) Horizontal Positioning



- ❑ Inland Survey - Conventional

- ❑ Shoreline – RTK/ ProBeacon

- ❑ *Offshore - WADGPS*



Determination of X, Y and Z - Methodologies

There are various methodologies in use nowadays to carry out a hydrographic survey, depending on the end use of the survey and the size of the area to be surveyed.

Horizontal position fixing measurements (X,Y) may be carried out using:

- hand-held optical square in conjunction with a float line;
- single theodolite in conjunction with a float line or twin theodolites;
- constant range tracking electronic positioning system (EPS); and
- differential Global Positioning System (GPS).

Vertical depth measurements (Z) may be carried out using:

- hand-held calibrated lead sounding line;
- simple engineering echosounder recording on paper; and
- advanced engineering echosounder recording on a data logger and linked to position fixer via integrated software (fully automated).

Horizontal position fixing measurements (X,Y)

Differential GPS

Differential GPS is the primary survey reference for all types of present-day engineering and construction activities. GPS is a continuous, all-weather, worldwide, satellite-based electronic positioning system. It is available to the general public and is known as a standard positioning service. Over the past several years, a technique has been developed to process signals from two GPS receivers operating simultaneously to determine the 3-D line vector between the two receivers. This technique is known as “differential positioning” (DGPS) and can produce real-time positions of a moving vessel.

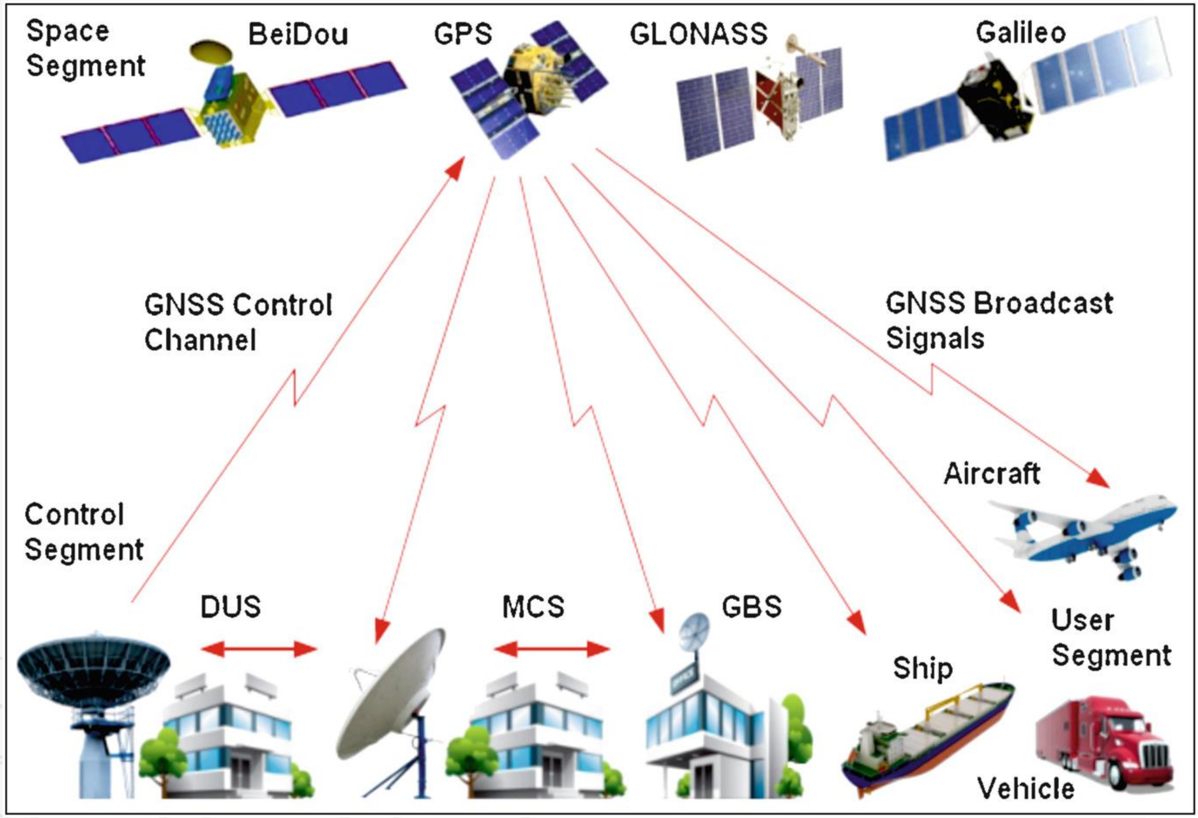
Differential GPS is the primary survey reference

a. RTK – Real Time Kinematik (JUPEM)
b. WADGPS
c. ProBeacon – MSK
d. Radiolink

GPS vs GNSS - What Engineers Need To Know

GNSS

GNSS stands for Global Navigation Satellite System, and is the standard generic term for satellite navigation systems that provide autonomous geo-spatial positioning with global coverage. This term includes e.g. the GPS, GLONASS, Galileo, Beidou and other regional systems. GNSS is a term used worldwide The advantage to having access to multiple satellites is accuracy, redundancy and availability at all times. Though satellite systems don't often fail, if one fails GNSS receivers can pick up signals from other systems. Also if line of sight is obstructed, having access to multiple satellites is also a benefit. Common GNSS Systems are GPS, GLONASS, Galileo, Beidou and other regional systems.



GPS

The United States' Global Positioning System (GPS) consists of up to 32 medium Earth orbit satellites in six different orbital planes, with the exact number of satellites varying as older satellites are retired and replaced. Operational since 1978 and globally available since 1994, GPS is currently the world's most utilized satellite navigation system.

Global Navigation Satellite System (GNSS) refers to a constellation of satellites providing signals from space that transmit positioning and timing data to GNSS receivers. The receivers then use this data to determine location.

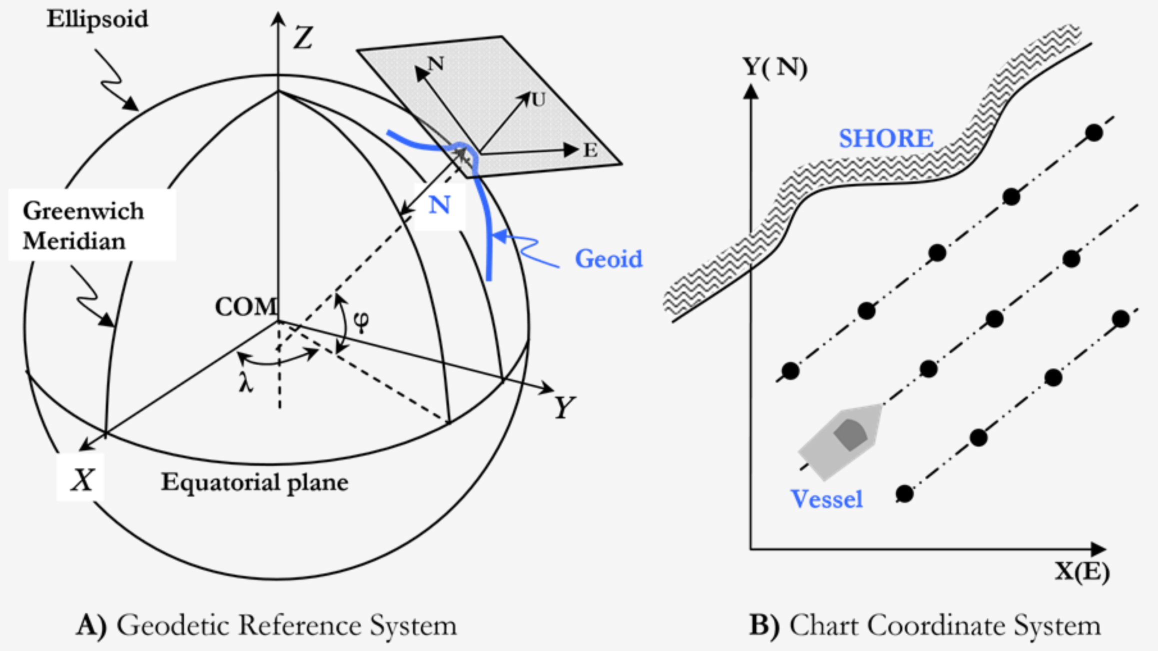
By definition, GNSS provides global coverage. Examples of GNSS include Europe's Galileo, the USA's NAVSTAR Global Positioning System (GPS), Russia's Global'naya Navigatsionnaya Sputnikovaya Sistema (GLONASS) and China's BeiDou Navigation Satellite System.

The performance of GNSS is assessed using four criteria:

- **Accuracy**: the difference between a receiver's measured and real position, speed or time;
- **Integrity**: a system's capacity to provide a threshold of confidence and, in the event of an anomaly in the positioning data, an alarm;
- **Continuity**: a system's ability to function without interruption;
- **Availability**: the percentage of time a signal fulfils the above accuracy, integrity and continuity criteria.

This performance can be improved by regional satellite-based augmentation systems (SBAS), such as the European Geostationary Navigation Overlay Service (EGNOS). EGNOS improves the accuracy and reliability of GPS information by correcting signal measurement errors and by providing information about the integrity of its signals.

Geodetic Reference and Coordinate Systems



Geodetic and Chart Coordinate Systems

Geocentric Cartesian coordinates, illustrated in Figure 2.1 (A), of a point located by GPS on the surface of the Earth is based on the WGS84 reference ellipsoid and defined as follows;

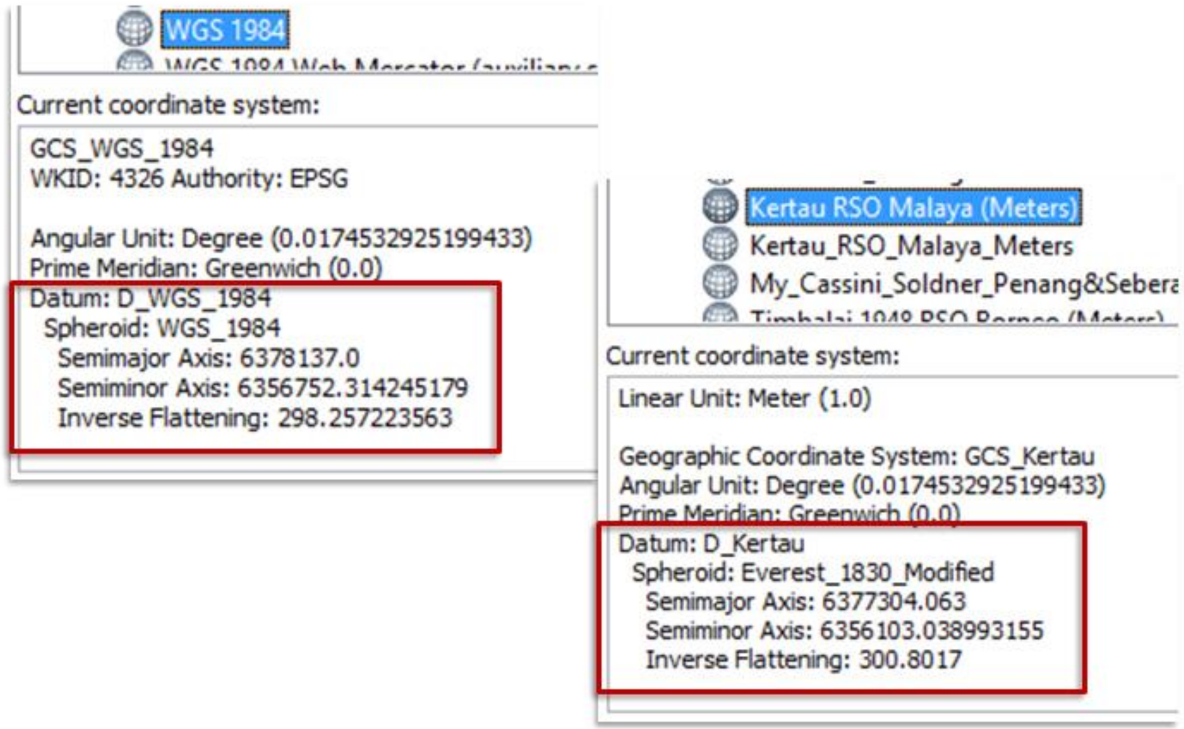
X = (NR + h)cosϕcosλ

Y = (NR + h)cosϕsinλ

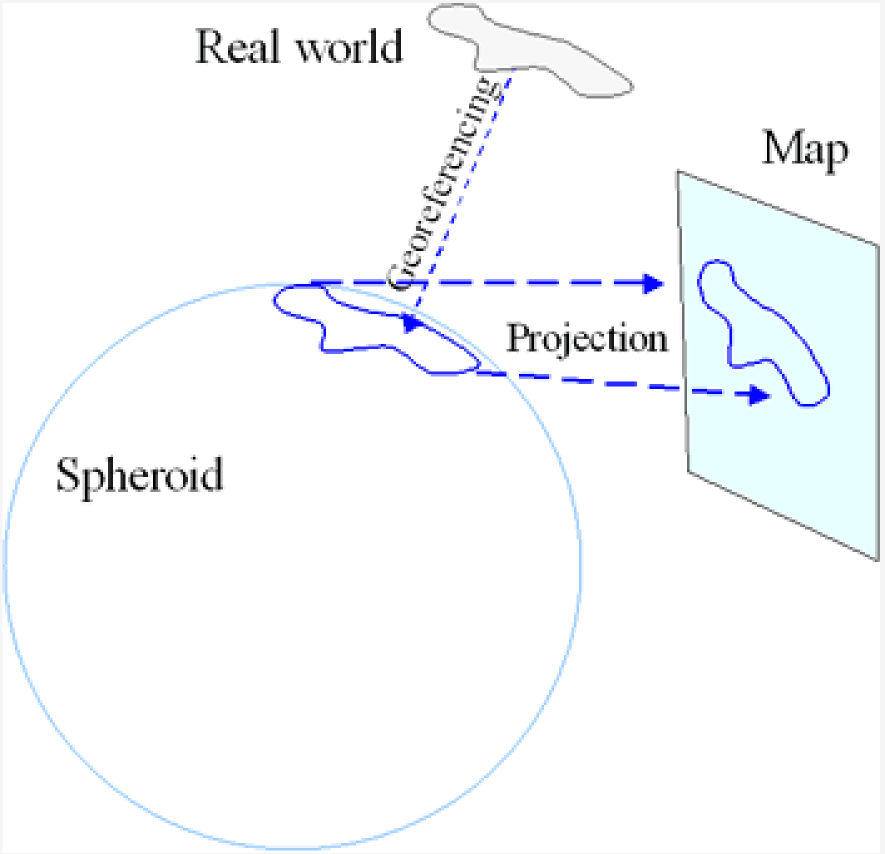
Z = [NR (1− e2) + h]sinϕ

Geodesy, Map Projections and Coordinate Systems

- Geodesy - the shape of the earth and definition of earth datums
- Map Projection - the transformation of a curved earth to a flat map
- Coordinate systems - (x,y) coordinate systems for map data



The spheroid models the shape of the earth's surface. It is an idealization that does not account for local changes in topography.



Georeferencing assigns locations (in three dimensions!) to points on a spheroid.

Projecting is an operation that mathematically distorts and shrinks a portion of the spheroid onto flat paper. Projecting can be undone ("inverted"). "Unprojection" expands a feature on a map and plasters it back onto the spheroid.It, too, is a mathematical operation.

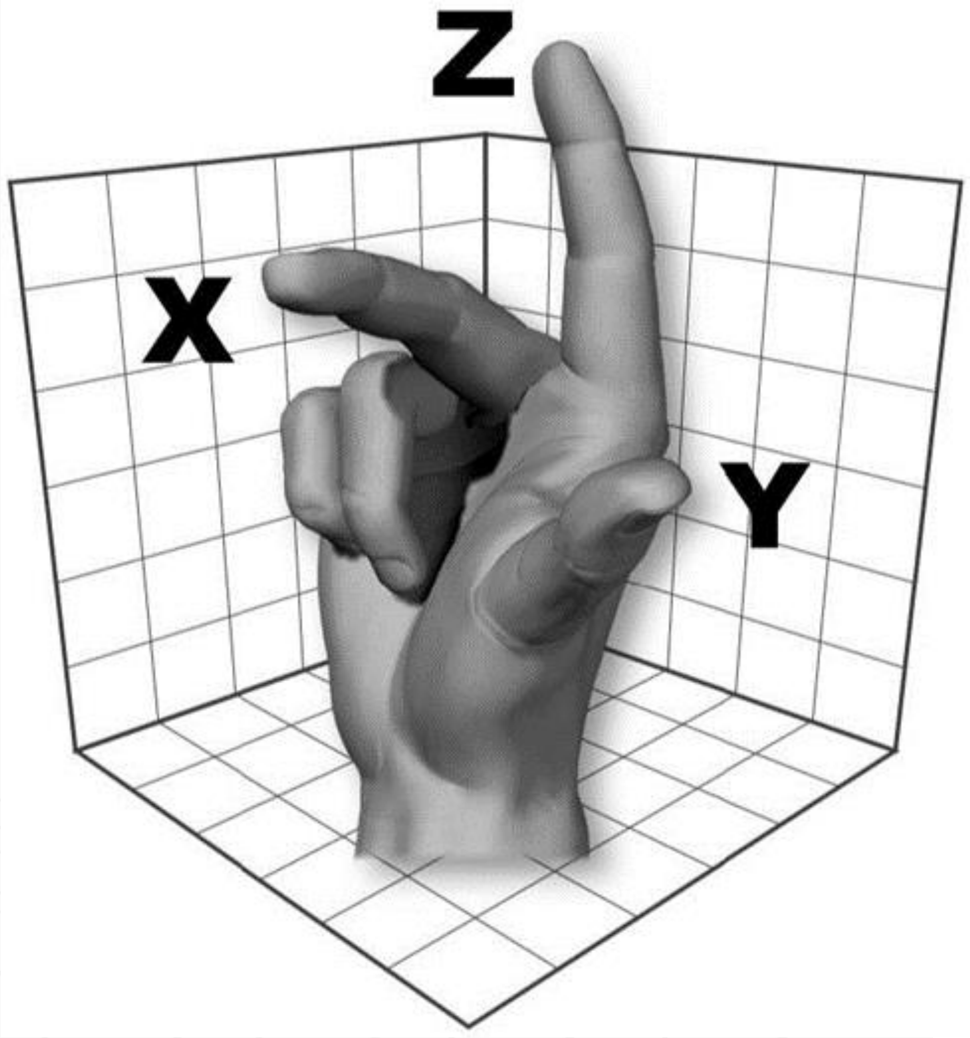
Georeferencing is done with a datum. A datum is usually given by a starting point and direction: it specifies where a clearly identifiable point on earth (the base point) should appear on the spheroid and it shows where a base direction, such as north, points on the spheroid at the base point. The base point and direction allow surveyors to determine the distance and angle of any other point on the earth. Moving in the corresponding direction on the spheroid for the same distance determines where the new point should go on the spheroid.

Topik ini memberi pendedahan kepada :

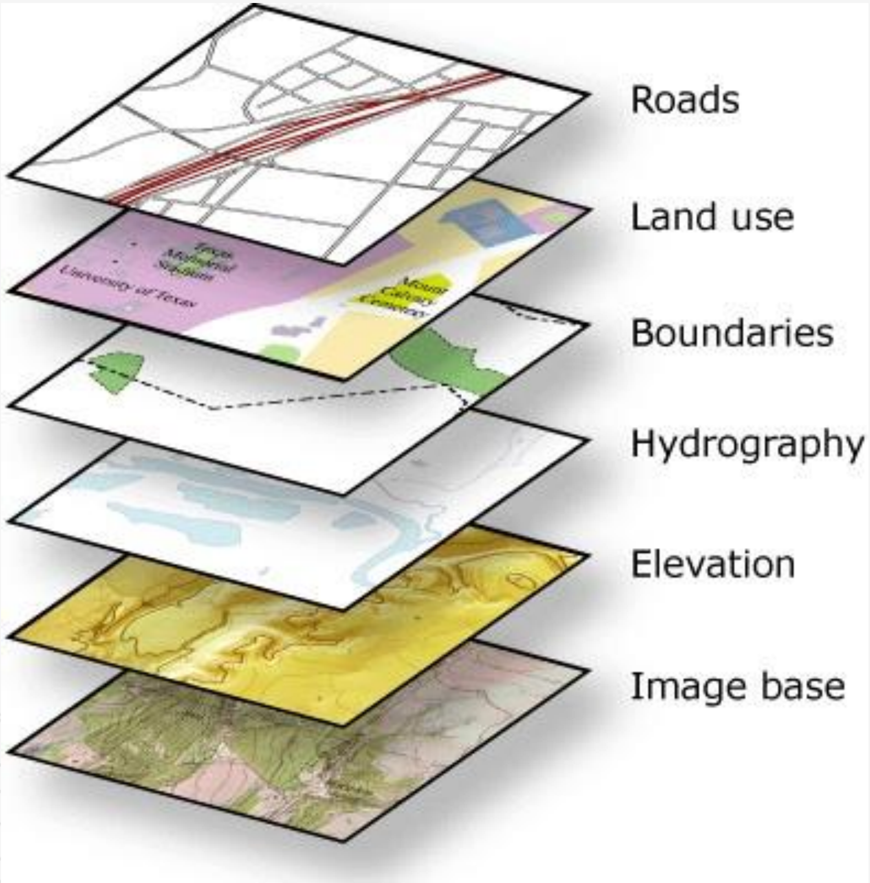
1. Sistem Koordinat

2. Jenis-jenis Sistem Koordinat

3. Unjuran



Sistem Koordinat merupakan satu kaedah bagi menyatakan kedudukan, lokasi atau suatu titik di atas permukaan bumi.



Pada hari ini terdapat begitu banyak sistem koordinat yang diasaskan kepada berbagai sistem rujukan, unit, unjuran dan datum geodetik.

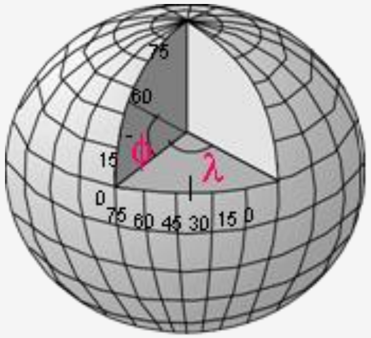
Secara umumnya sistem koordinat ini boleh dibahagikan kepada 2 :

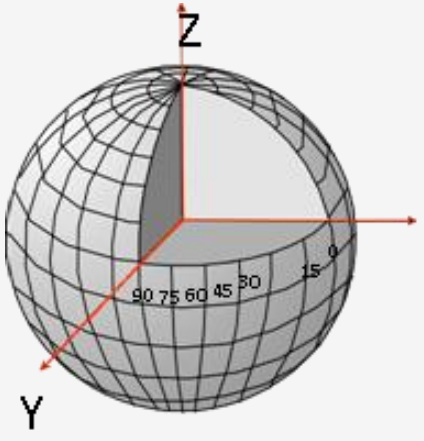
1. Sistem Koordinat Geografi
2. Sistem Koordinat Planar

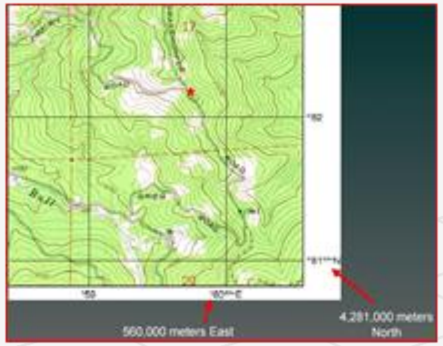
Coordinates

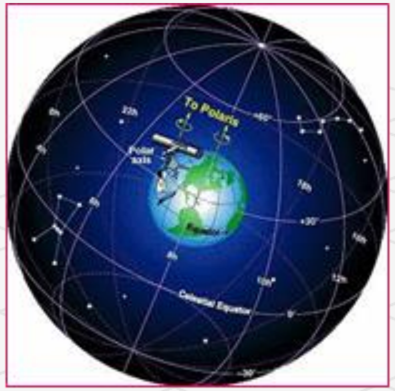
Coordinates

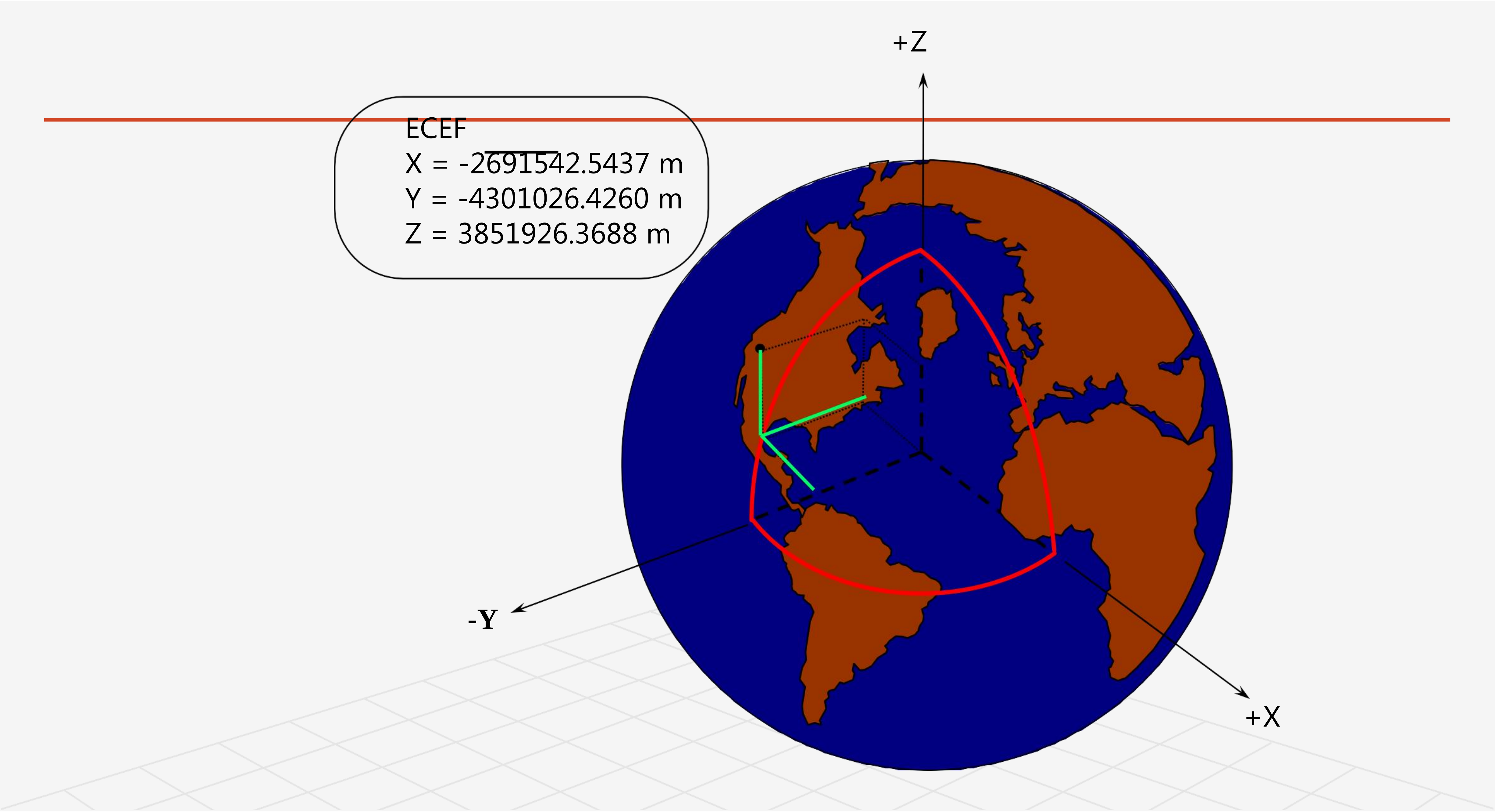
- Geodetic Coordinates (MRT/BT68, PMSGN94, EMSGN97, MPGN2000, GDM2000)
  - Geographic coordinates ϕ λ h
  - Cartesian coordinates X Y Z
- Plane coordinates (Cassini, RSO)
  - map coordinates N E
- Celestial coordinates
  - Sky coordinates RA δ










+Z
ECEF
X = -2691542.5437 m
Y = -4301026.4260 m
Z = 3851926.3688 m
-Y
+X

a = semi-major axis

b = semi-minor axis (a – b)

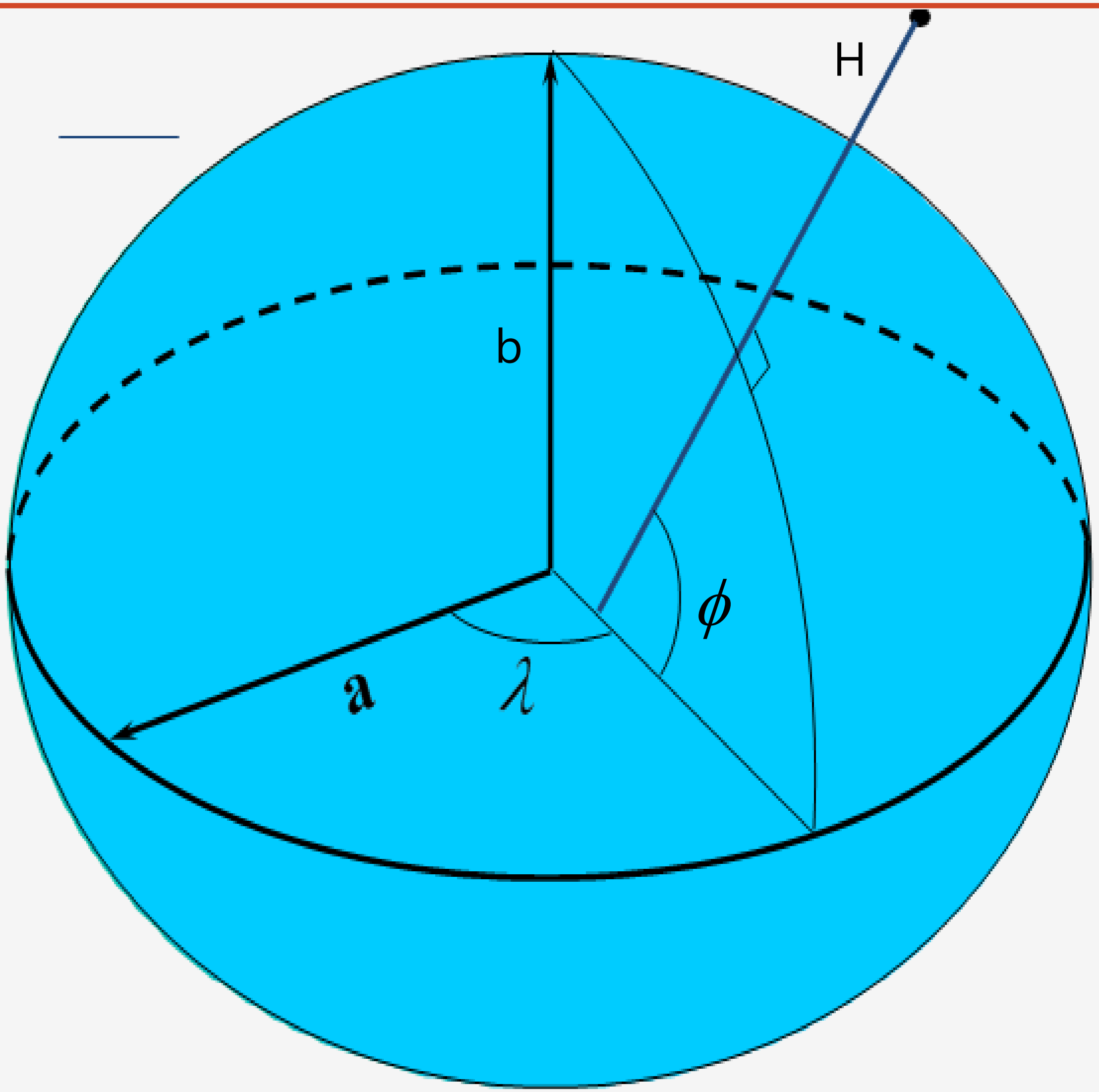
longitude

$\phi \equiv$ latitude $\lambda \equiv$

Flattening $f \equiv \frac{(a - b)}{a}$

H ≡ ellipsoidal height

ϕ



WGS-84 Ellipsoid
a = 6378137.000000 m
b = 6356752.314245 m
1/f = 298.2572235630

ECEF and WGS-84   ECEF (acronym for earth-centered, earth-fixed)

ECEF

X = -2691542.5437 m

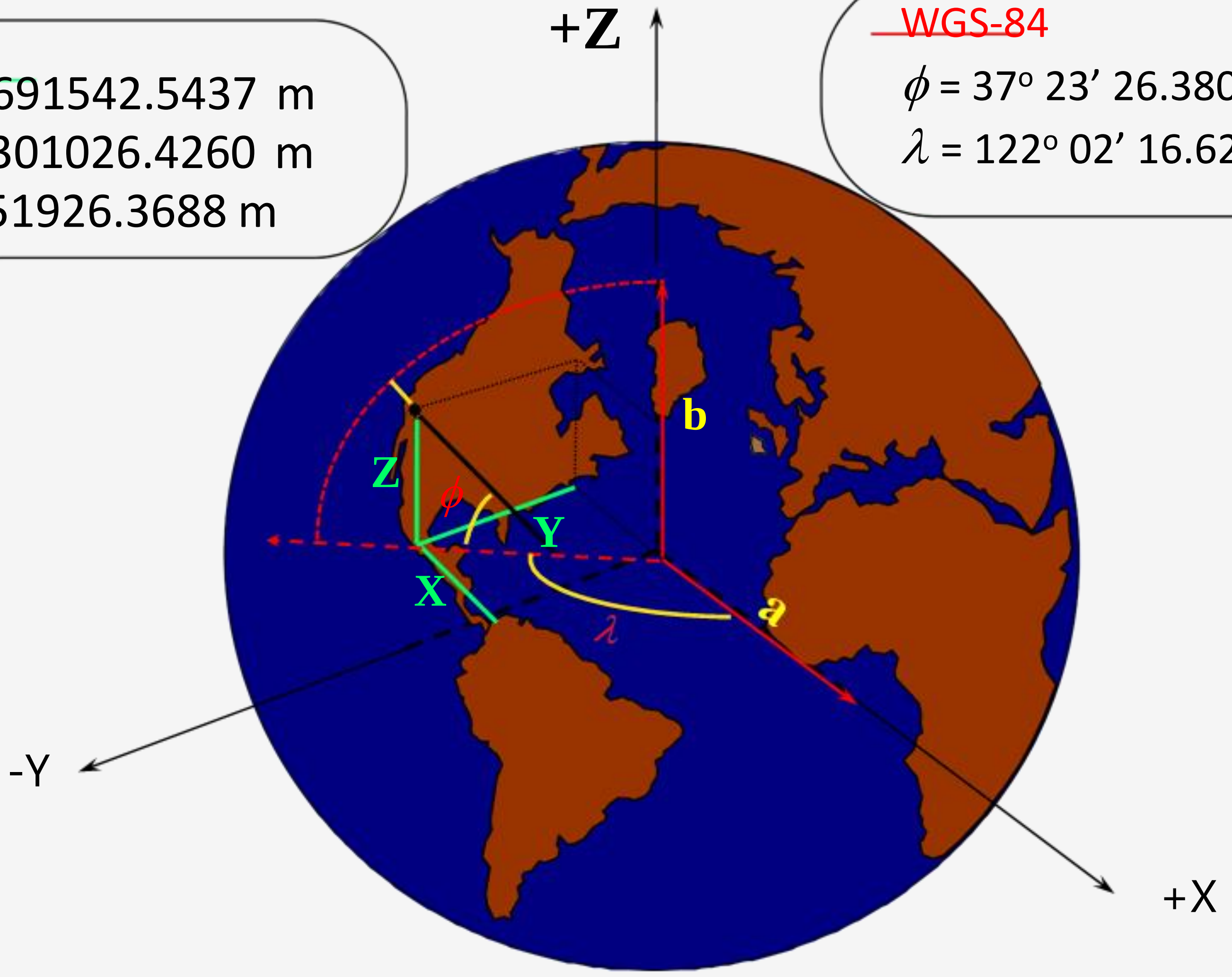
Y = -4301026.4260 m

Z = 3851926.3688 m

~~WGS-84~~

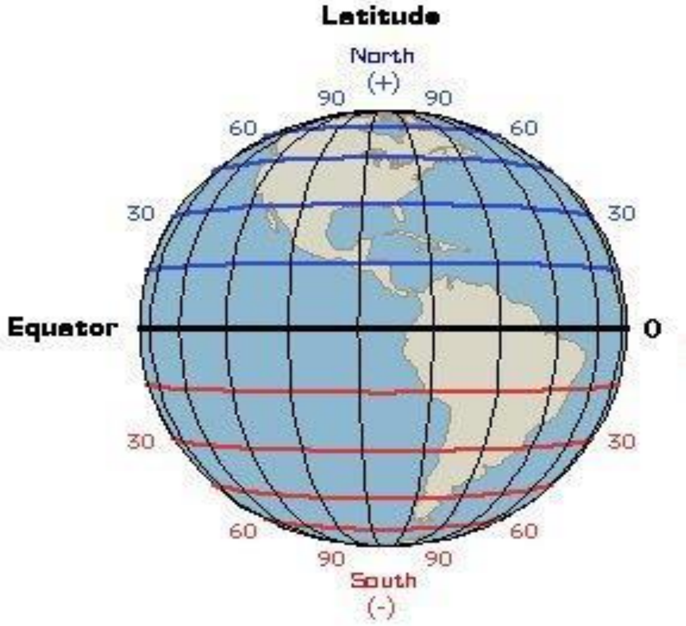
ϕ = 37° 23’ 26.38035” N

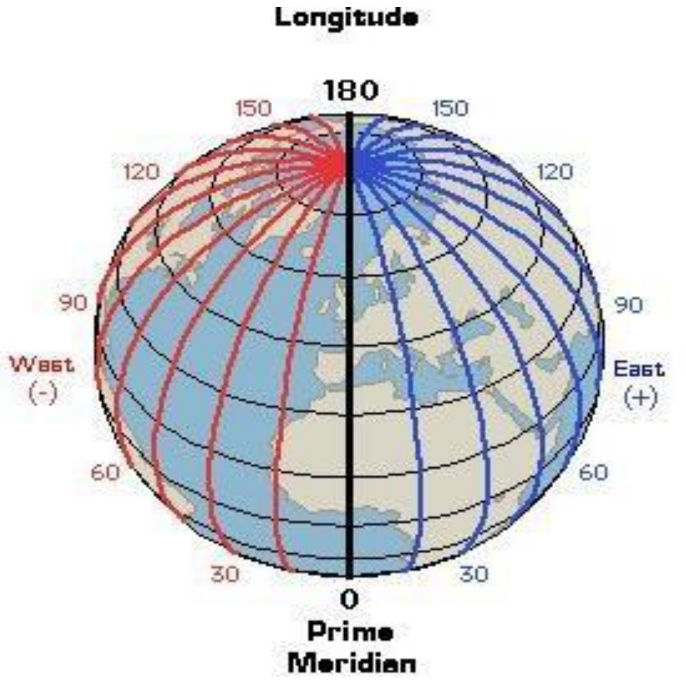
λ = 122° 02’ 16.62574” W h = -5.4083 m



Sistem Koordinat Geografi

- Merupakan sistem yang mengunakan garis lintang (latitud) dan garis bujur (longitud).



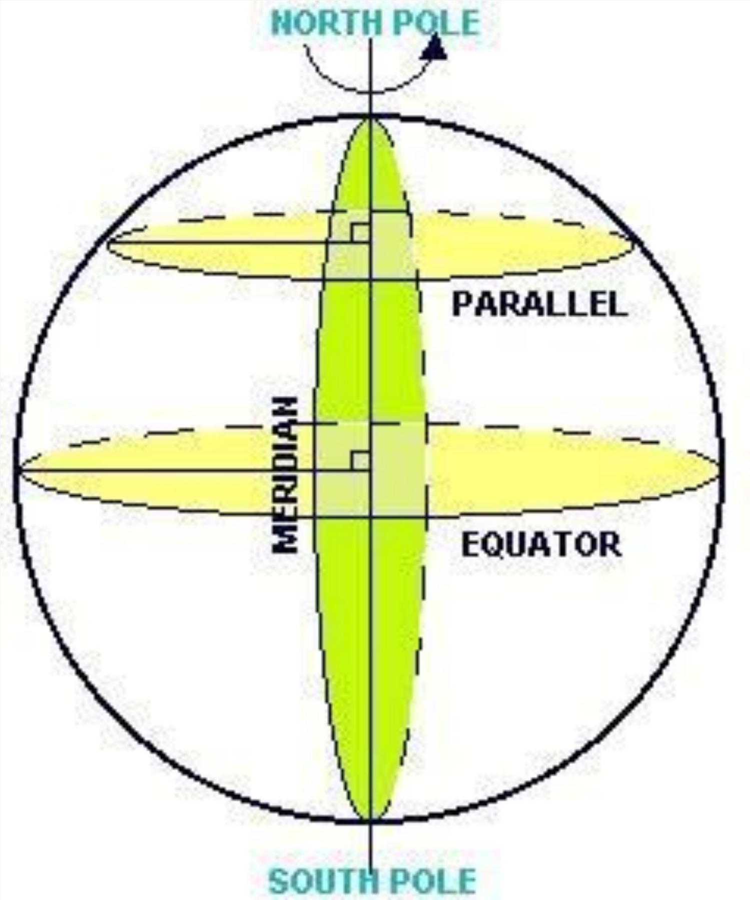


- Sistem utama untuk penentuan lokasi asas umpamanya untuk tujuan navigasidan pengukuran asas.

- Koordinat geografi diasaskan kepada paksi putaran bumi dan planar khatulistiwa.

- Tempat di mana paksi putaran ini timbul dikenali sebagai utara geografi atau kutub utara dan berlawanan selatan geografi (kutub selatan)

- Penetapan lokasi memerlukan penentuan jarak antara utara dan selatan yang dipanggil garis lintang (latitud) dan jarak antara timur dan barat yang dipanggil garis bujur (longitud

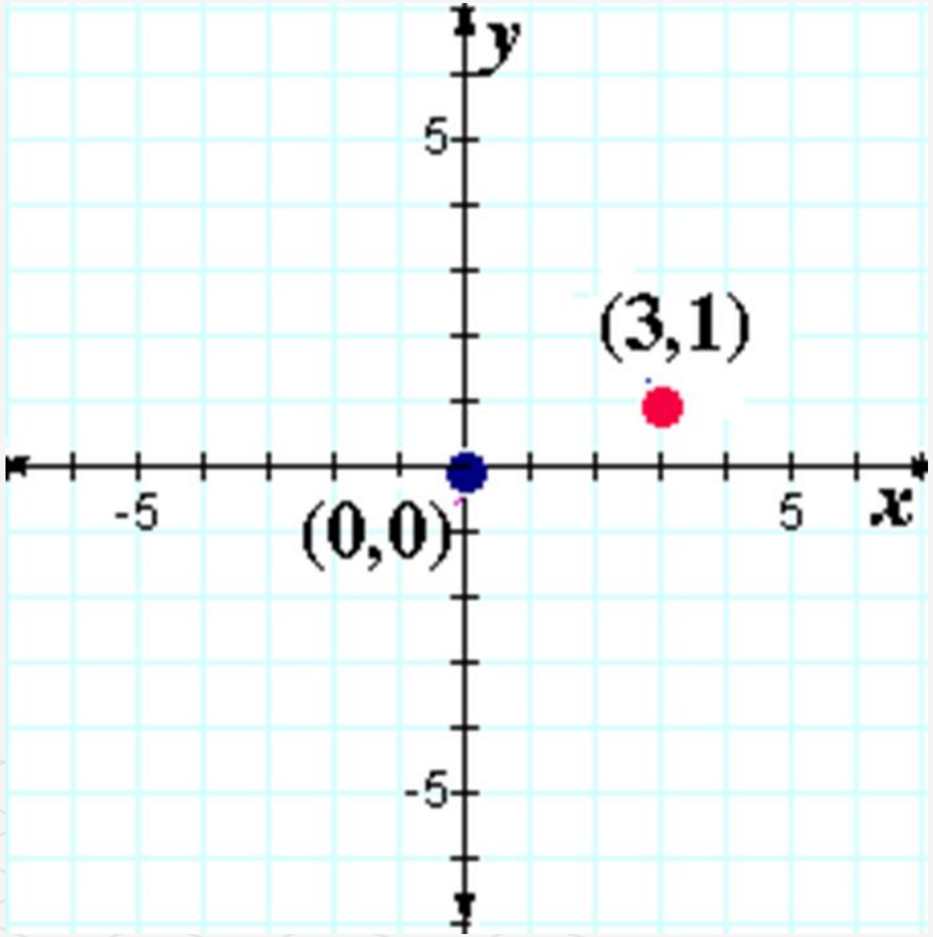


Sistem Koordinat Planar/Cartesian

- Sistem kordinat planar segiempat bujur juga merupakan sistem yang agak lama.

- Sistem kordinat ini terdiri daripada persimpangan garisan-garisan bersudut tepat (perpendicular) antara satu sama lain yang mengandungi dua paksi utama : paksi X dan Y.

- Paksi menegak adalah Y dan paksi mendatar adalah X.



X = Timuran, Y = Utaraan

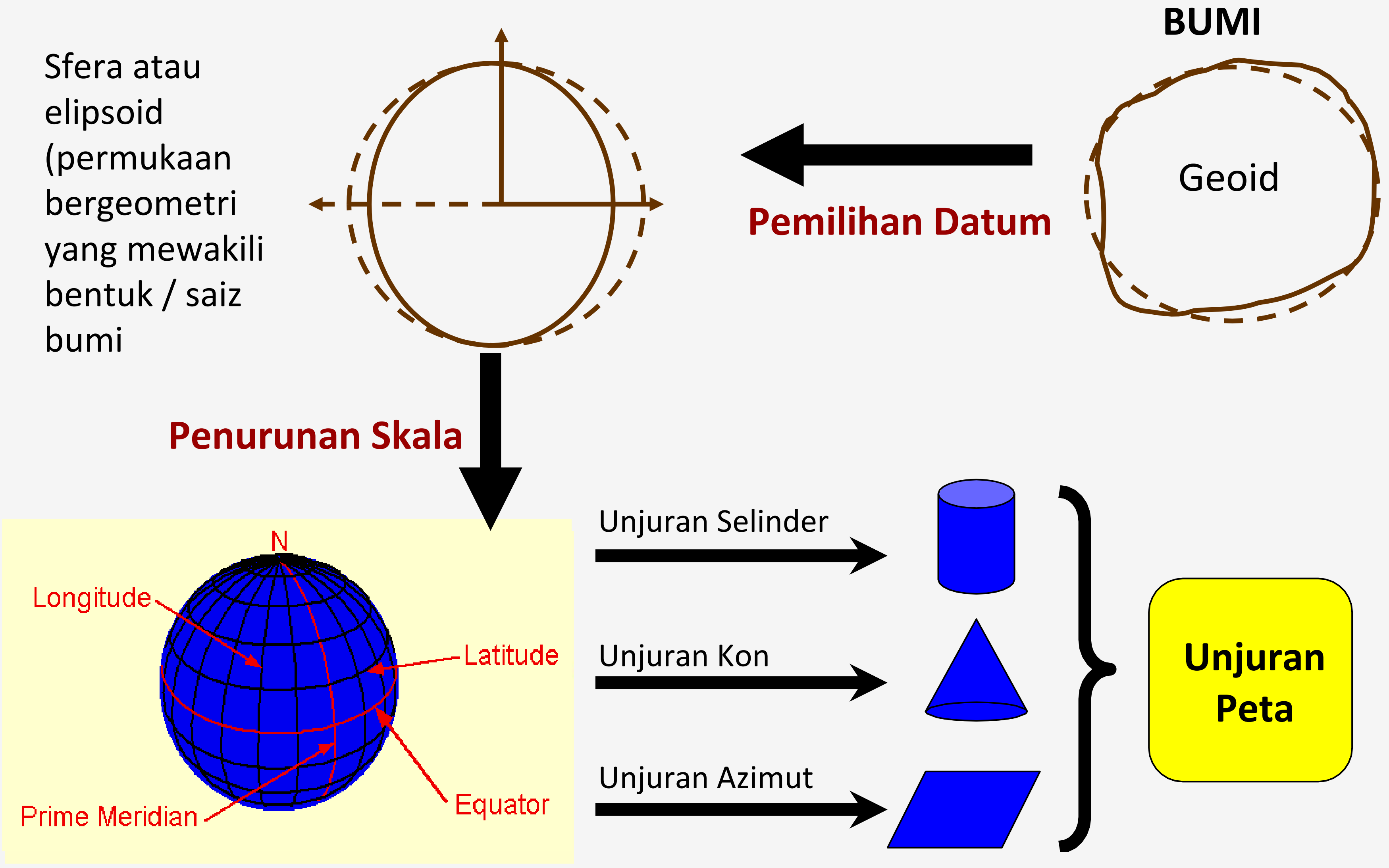
- Biasanya Koordinat Planar digunakan bagi peta yang berskala besar kerana herotan akibat daripada transformasi permukaan sfera ke dalam bentuk planar menyebabkan peta berskala kecil tidak sesuai untuk rujukan terperinci dan pengiraan.

- Malaysia menggunakan Sistem Koordinat Rectified Skew Orthomorphic (RSO) bagi peta topografi dan Cassini Soldner bagi peta kadaster/lot tanah

Mengapa perlu ada unjuran ?

- Masalah memetakan sistem koordinat 3-Dimensi ke permukaan rata
- Peta adalah di dalam 2-Dimensi
- Adalah mustahil untuk menukarkan sfera ke permukaan rata tanpa melibatkan erotan

- Unjuran Pemetaan Topografi di Malaysia adalah menggunakan sistem Bentuk Benar Serong Ditepati (BBST) atau lebih sinonim dengan nama Rectified Skew Orthomorphic (RSO)
- Kerja-kerja kadaster pula menggunakan Cassini- Soldner (Cassini)
- Kedua-dua sistem unjuran ini menggunakan elipsoid
- Modified Everest sebagai rujukan.


BUMI
Sfera atau elipsoid (permukaan bergeometri yang mewakili bentuk / saiz bumi)
Geoid
Pemilihan Datum
Penurunan Skala
N
Longitude
Latitude
Prime Meridian
Equator
Unjuran Selinder
Unjuran Kon
Unjuran Azimut
Unjuran Peta

- Di Malaysia pembinaan dan pengeluaran peta rasmi telah dipertanggungjawabkan kepada Jabatan Ukur dan Pemetaan Malaysia (JUPEM).
- Banyak peta berskala kecil yang meliputi seluruh negara dan negeri dikeluarkan oleh JUPEM. Seperti peta pentadbiran dan ciri-ciri fizikal.
- 3 Unjuran peta yang lazim iaitu :

i. Sistem Koordinat Geografi (Lat-Long)
ii. Cassini Soldner
iii. Bentuk Benar Serong di-Tepati (Rectified Skew Orthomorphic-RSO)

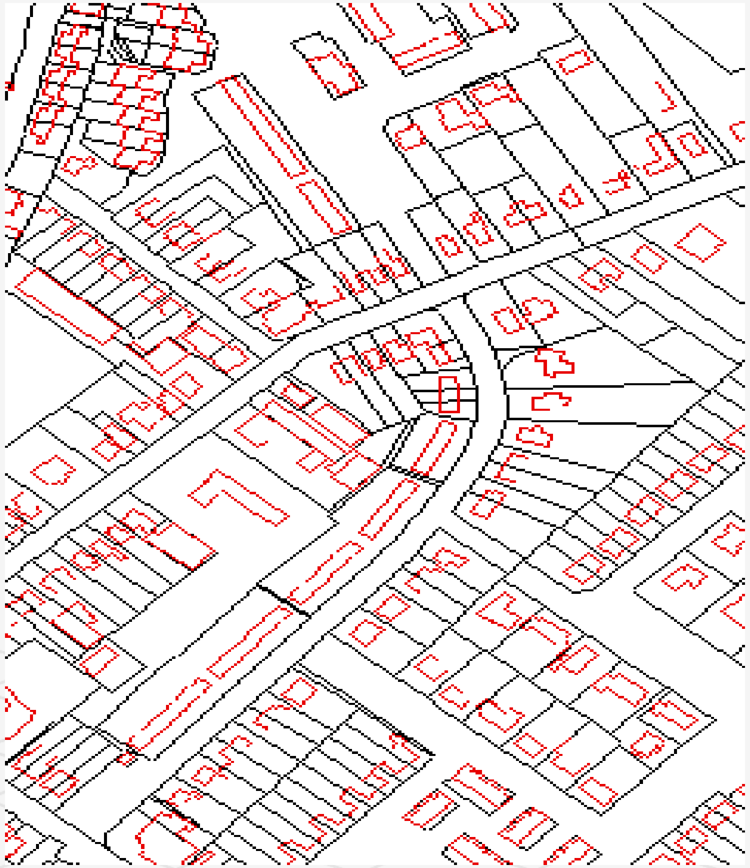
- Sistem koordinat Geografi menggunakan garis lintang dan garis bujur sebagai sistem koordinat segiempat bujur.
- Ia merupakan sistem seluruh dunia yang sejagat.
- Banyak peta yang berskala kecil yang meliputi seluruh negara dan negeri yang dikeluarkan oleh JUPEM seperti peta pentadbiran dan ciri-ciri fizikal menggunakan sistem ini.

sistem kordinat Cassini Soldner

- Unjuran peta Cassini Soldner digunakan untuk peta kadaster (lot tanah).

- Ia sesuai bagi pemetaan skala besar kawasan yang hampir meridian pusat. (unjuran selinder transverse)

- Oleh itu di Malaysia unjuran ini mempunyai origin tersendiri bagi hampir setiap negeri bagi mengekalkan skala yang betul. Dengan kata lain setiap negeri mempunyai sistem koordinat atau grid masing-masing.



- Memandangkan setiap negeri mempunyai sistem kordinat Cassini Soldner masing-masing, maka secara dasarnya peta-peta kadaster negeri yang berbeza tidak boleh dicantumkan jika menggunakan unjuran Cassini Soldner.

- Ini telah menyukarkan usaha untuk mewujudkan satu pangkalan tanah nasional terutamanya dengan perkembangan pesat penggunaan sistem maklumat geografi di Malaysia.

- Salah satu alternatif ialah menukarkan unjuran ini kepada unjuran RSO yang merupakan sistem unjuran nasional.

- Namun begitu proses penukaran ini biasanya akan memperkenalkan herotan atau ralat dalam peta yang terhasil.

RSO

- Unjuran Bentuk Benar Serong Di Tepati (RSO) merupakan sistem koordinat nasional yang di gunakan di Malaysia, singapura dan Brunei.
- Unjuran ini adalah dari jenis Mercator Serong Hotine (Hotine Oblique Mercator) ia dibina khusus untuk negara tertentu sahaja maka kegunaannya terhad ke kawasan berkenaan sahaja.
- Memandangkan ia dibina khusus untuk negara tertentu (sebagai grid kebangsaan) maka kegunaannya adalah terhad ke kawasan berkenaan sahaja.
- Jadi sistem unjuran RSO Malaysia tak sama dengan unjuran yang dibina untuk negara lain kerana origin dan garis selari masing-masing berbeza.

Geographical position, projection and grid

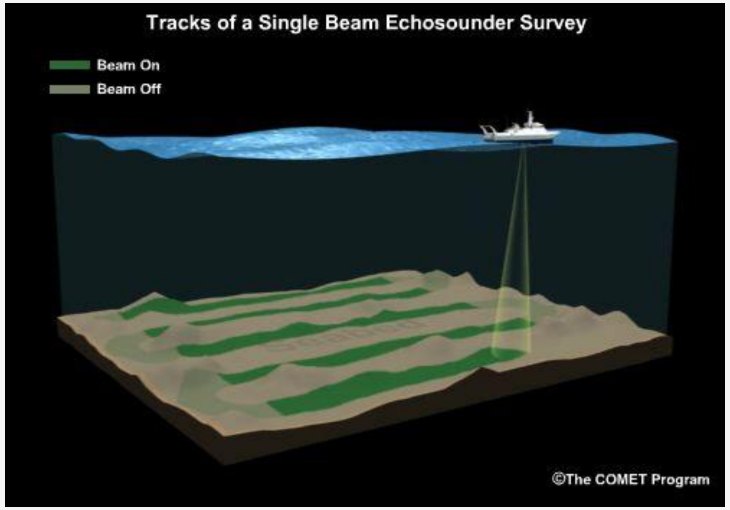
KPUP JUPEM

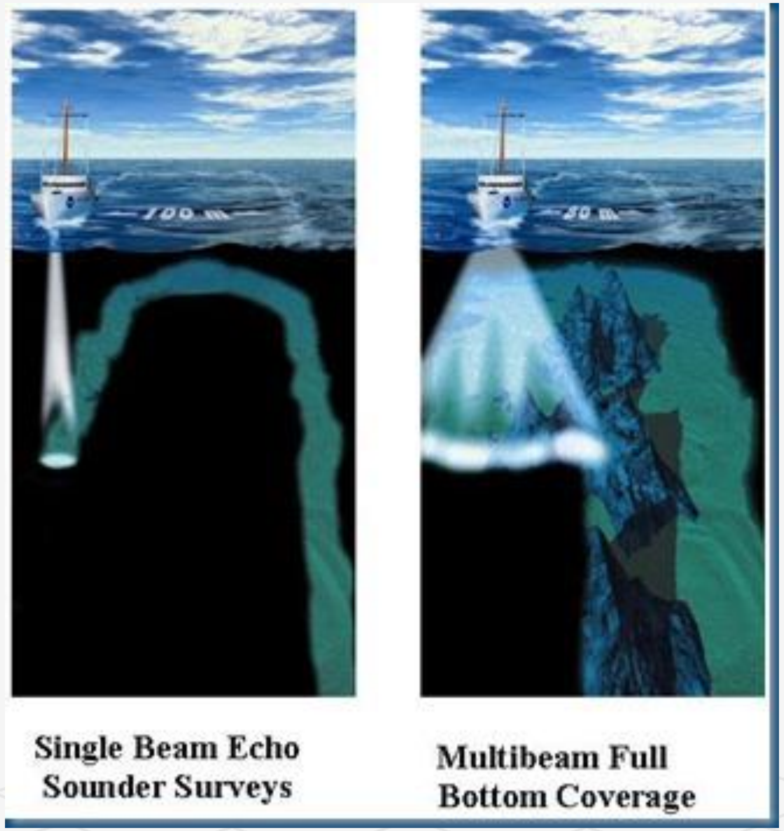
https://www.jupem.gov.my/jupem18a/assets/uploads/files/pekeliling/e6846-pkpup3-2009.pdf

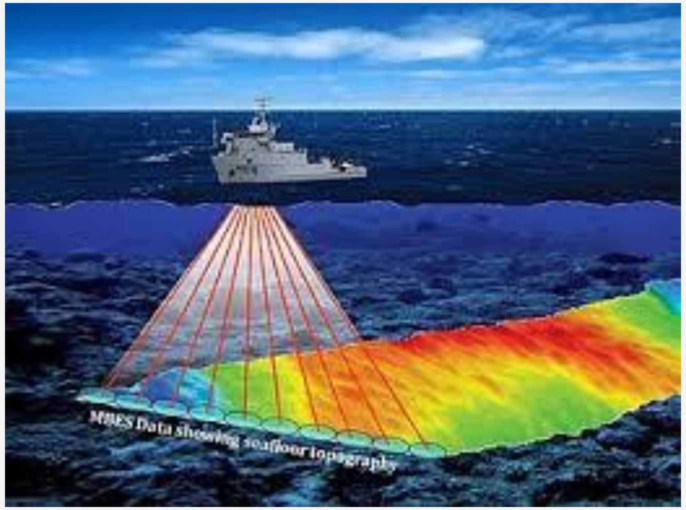
Basic Measurements and Survey Equipment

Basic Measurements and Survey Equipment

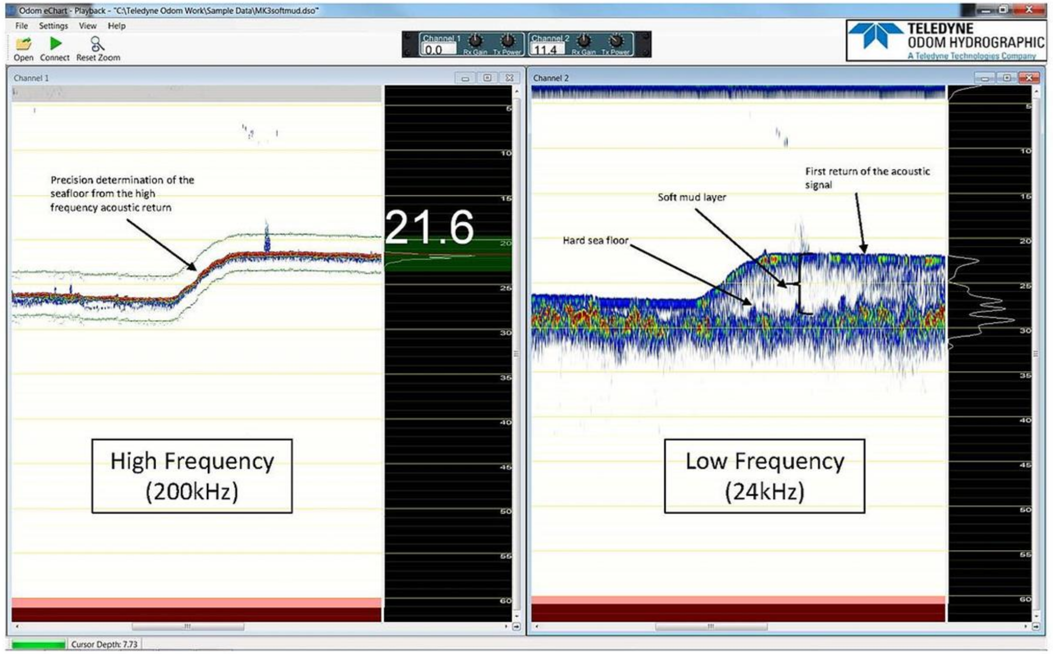
Equipment – SBES @ MBES

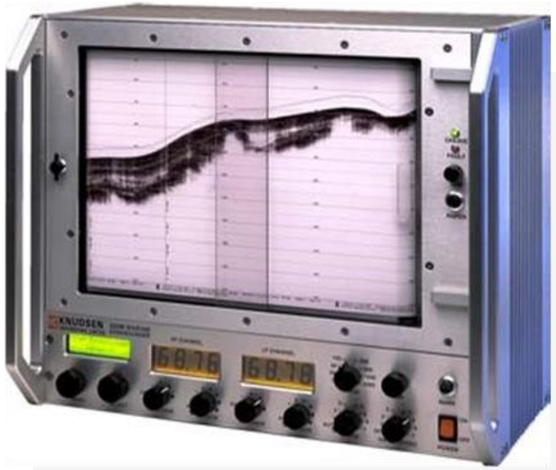






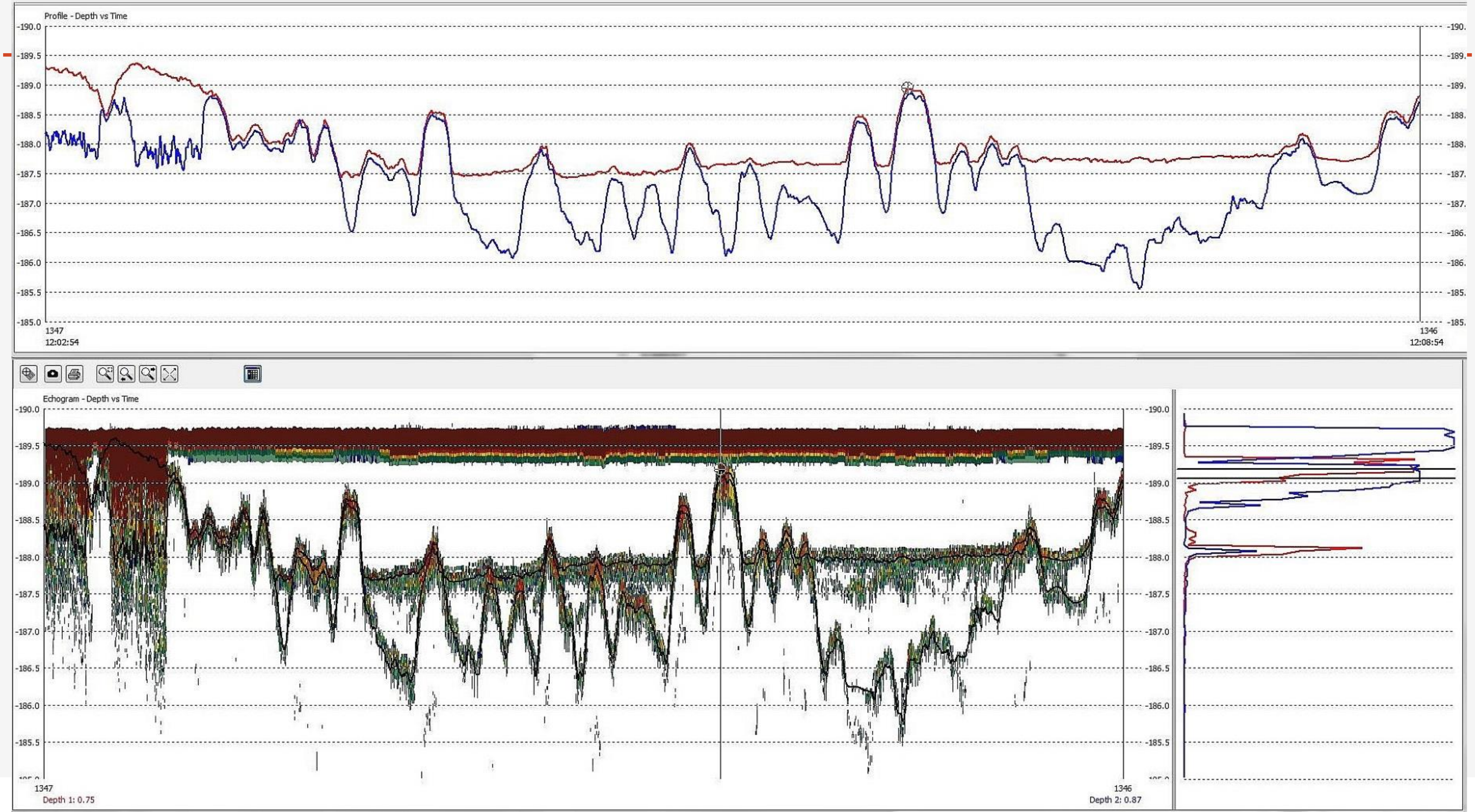
Typically, high frequency (192 or 200 kHz) sonar





Frequency

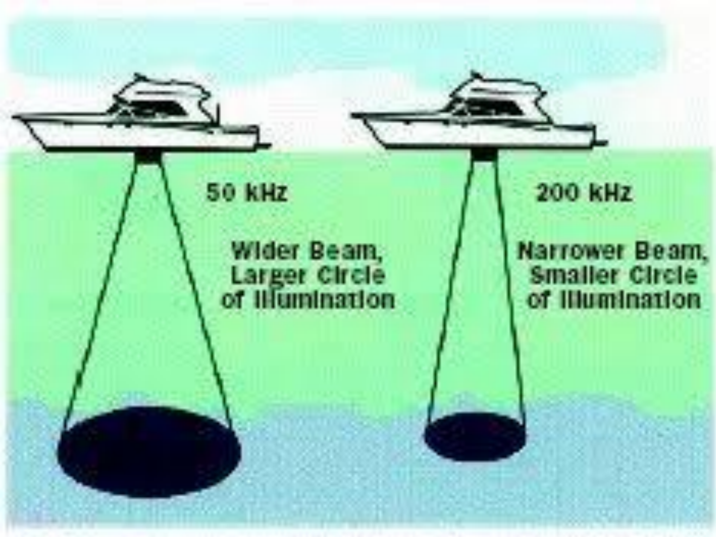
Most single frequency sonar units operate in the range of about 24 - 210 kHz (kilohertz). A few are dual frequency capable, meaning they can use both 50 and 200 kHz transducers. Typically, high frequency (192 or 200 kHz) sonar units provide the best resolution and definition of submerged structures and targets. 50 kHz units have much greater depth penetration capability, but show less definition. 24 kHz transducers also have a much wider cone angle than 192 or 210 kHz transducers.

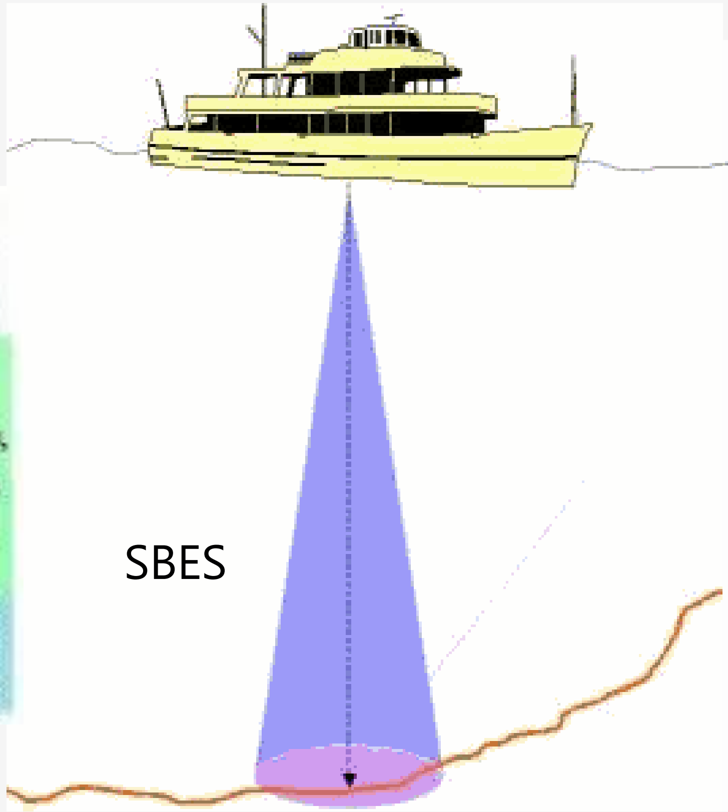

Profile - Depth vs Time
-190.0
-189.5
-189.0
-188.5
-188.0
-187.5
-187.0
-186.5
-186.0
-185.5
-185.0
1347
12:02:54
1346
12:08:54
Echogram - Depth vs Time
1347
Depth 1: 0.75
1346
Depth 2: 0.87

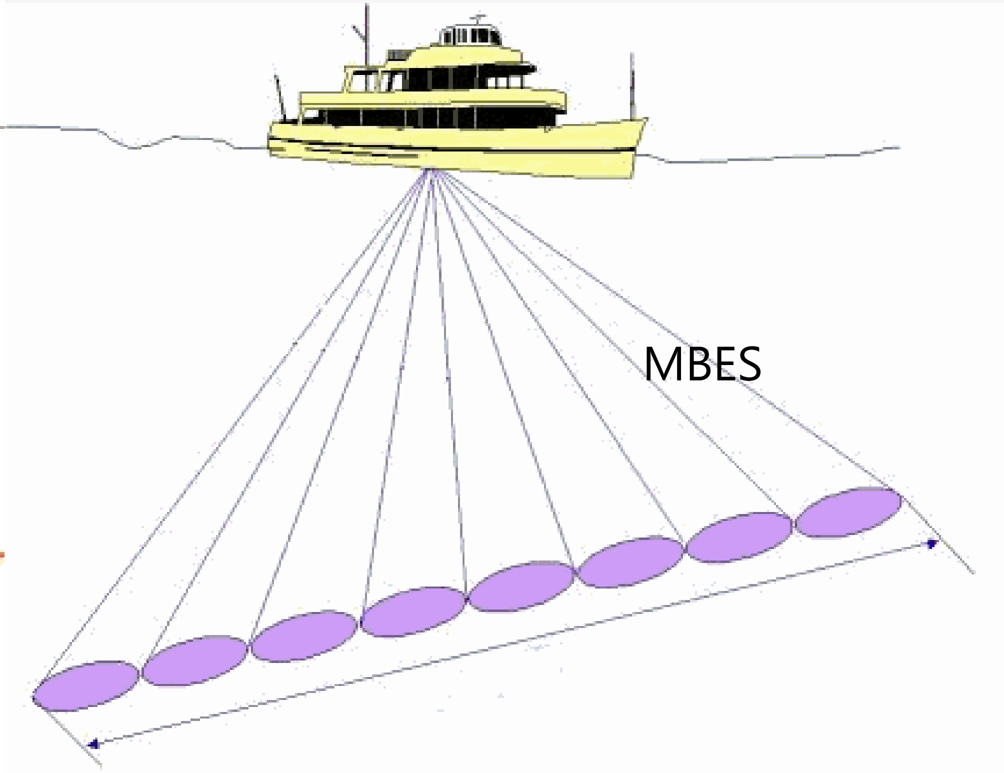
Hydrographic Echo Sounders

Hydrographic echo sounders are used to measure the depth to the seafloor by using the properties of acoustic waves. The principle of echo-sounders is basic - by measuring the two-way travel time between the acoustic waves transmitted on sea surface and those reflected at seafloor.

Echo-sounders are classified into two types; **Single-Beam Echo Sounder (SBES) and Multi-Beam Echo Sounder (MBES).** The names of 'single' and 'multi' stem from the number of depth points measurements collected at the same time.







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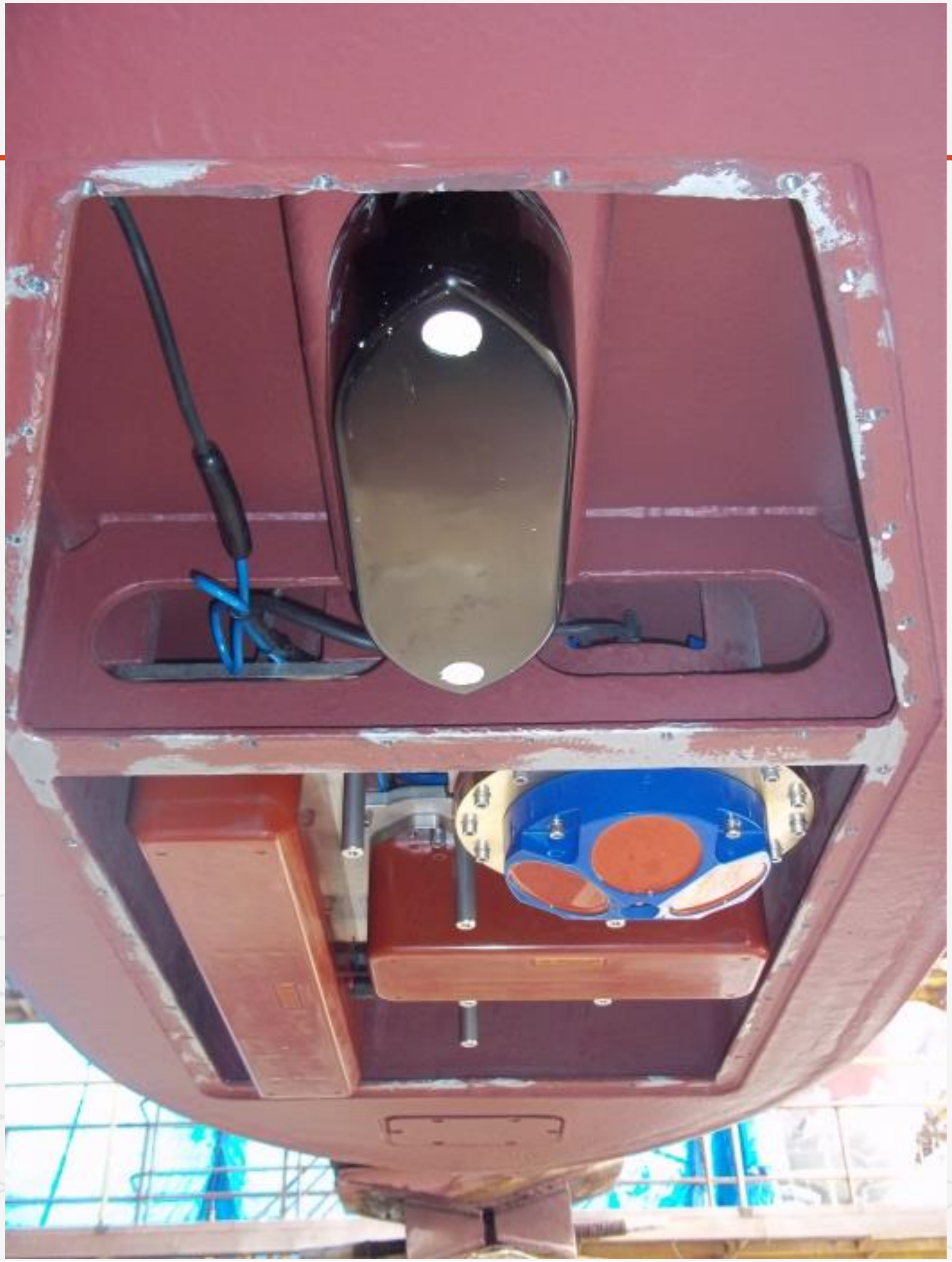
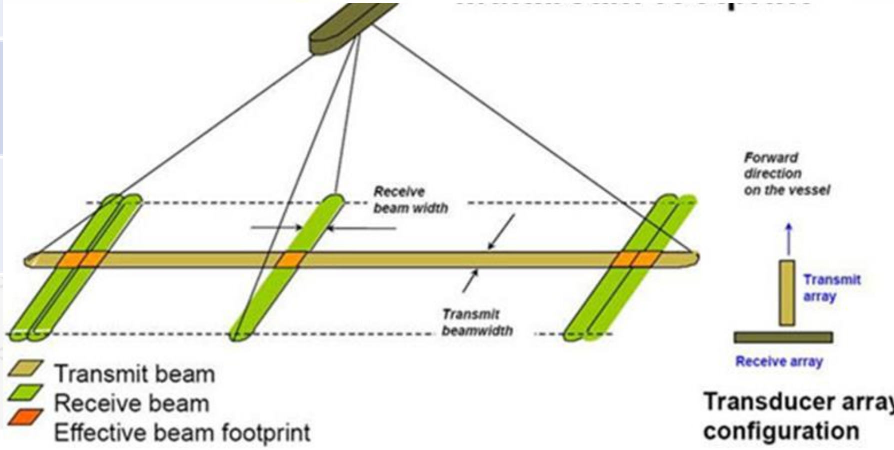
Echo-sounders are classified into two types; Single-Beam Echo Sounder (SBES) and Multi-Beam Echo Sounder (MBES). The names of 'single' and 'multi' stem from the number of depth points measurements collected at the same time.

A SBES can measure only one point per acoustic echo wave (echo) emitted. The specifications of SBES are defined by beam angle and frequency of transmitted acoustic wave from the transducer as well as many other sonar parameters which may be selected in order to provide water depth capabilities from less than 1 meter to full ocean depth.





Approximate footprint coverage for different beam width transducers				
		BEAM WIDTH		
Project depth	1.5 deg	3 deg	8 deg	20 deg
10 ft	< 1 sq ft	< 1 sq ft	< 2 sq ft	10 sq ft
25 ft	< 1 sq ft	< 2 sq ft	10 sq ft	60 sq ft
50 ft	< 2 sq ft	5 sq ft	40 sq ft	250 sq ft
75 ft	3 sq ft	10 sq ft	90 sq ft	550 sq ft



System	Frequency	Beam widths	Typical depth	Max depth
MB2	200 - 460kHz	1.8°x 1.8°	0.5 - 100m	240m
SeaBat T20-P	190 - 420kHz	1°x 1°	0.5 - 375m	575m
SeaBat T20-R	190 - 420kHz	1°x 1°	0.5 - 375m	575m
SeaBat T20-R IDH	190 - 420kHz	1°x 1°	0.5 - 375m	575m
SeaBat T50-P	190 - 420kHz	0.5°x 1°	0.5 - 375m	575m
SeaBat T50-R	190 - 420kHz	0.5°x 1°	0.5 - 375m	575m
SeaBat T50-R IDH	190 - 420kHz	0.5°x 1°	0.5 - 375m	575m
SeaBat T50 Extended Range	150 – 420kHz	0.5°x 0.5°	0.5 - 750m	900m
SeaBat 7160	41-47kHz	2.0°x 1.5°	3 - 2750m	3000m
HydroSweep MD50	52-62 kHz	0.5°, 0.75°, 1°, 1.5°	5 - 2000m	2500m
HydroSweep MD30	24-30 kHz	1°, 1.5°, 3°	10 - 6000m	7000m
HydroSweep DS	14-16 kHz	0.5°, 1°, 2°	10 - 11000m	11000m
Parasound M D, P35, P70	0.5-6 kHz	4.5°x 5.0°	10 - 11000m	11000m

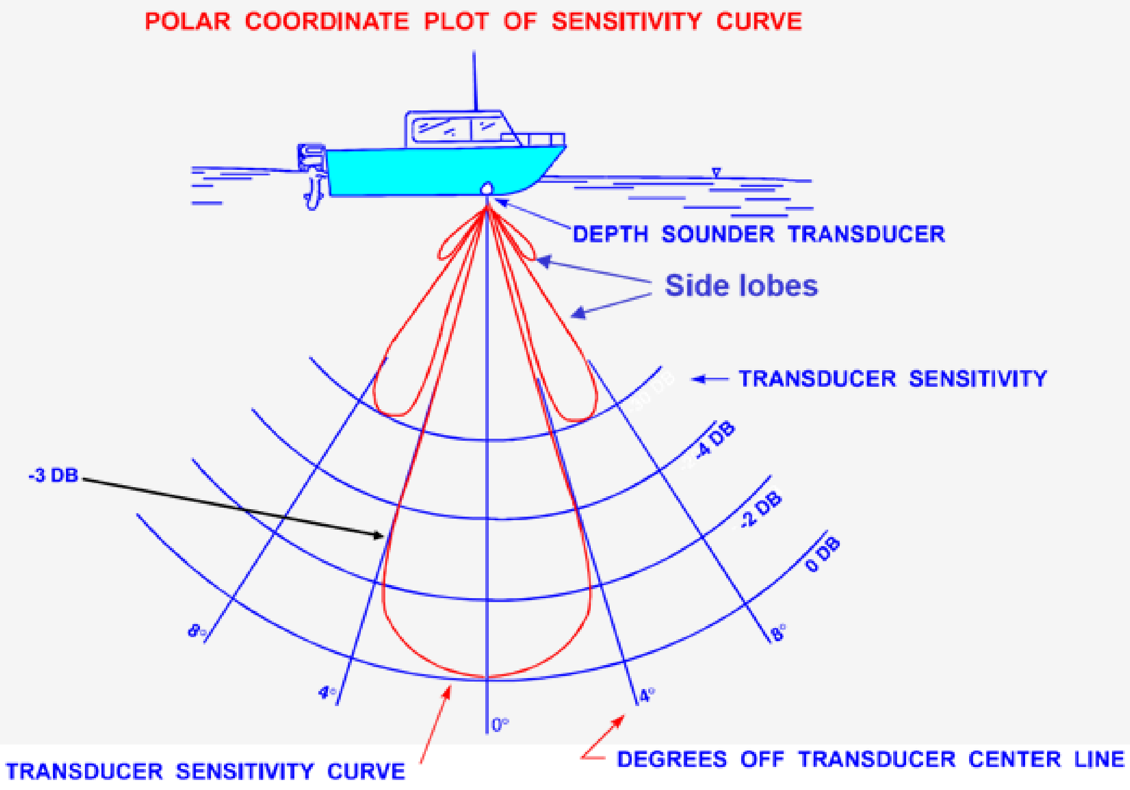
A transducer initiates a sonic pulse. The sound wave propagates through the water and a receiver detects the return pulse. A basic technique of depth measurement is using a Single Beam Echo Sounder (SBES). An echo sounder performs the following operations;

- Transmit Sound
- Measure round trip travel time.
- Use sound speed to get distance

The depth (or distance) is computed from the two-way travel time as

The transducer interfaces with the depth sounder which outputs a profile of the bathymetry or "bottom return". Two important components of depth sounding equipment include the frequency and the beam divergence (or cone angle).

$$\textit{Distance/depth} = (\textit{time} \times \textit{speed})/2$$



1.3. ***Depth measuring equipment***

A transducer initiates a sonic pulse. The sound wave propagates through the water and a receiver detects the return pulse. A basic technique of depth measurement is using a Single Beam Echo Sounder (SBES). An echo sounder performs the following operations;

- Transmit Sound
- Measure round trip travel time.
- Use sound speed to get distance

The depth (or distance) is computed from the two-way travel time as

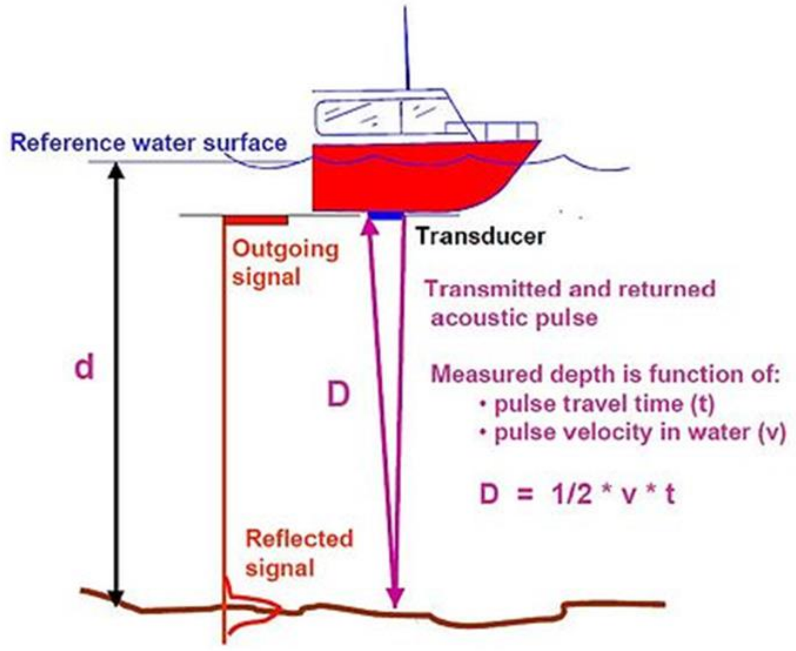
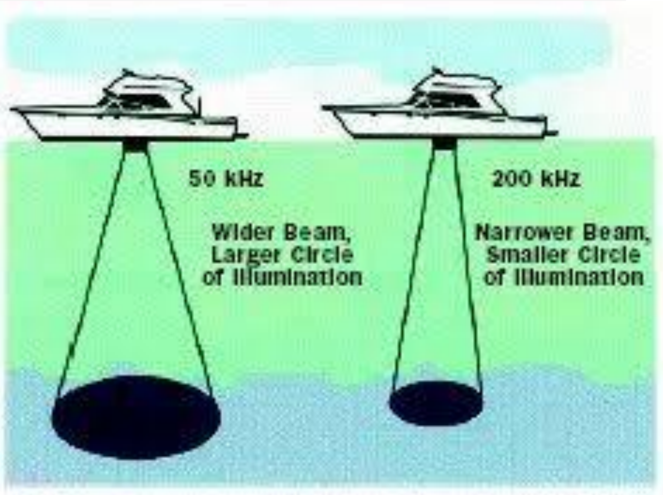


Figure 9-1. Acoustic depth measurement

Cone Angle

A transducer's cone angle determines its footprint size and coverage area of the underwater world. The wider the cone angle the greater the footprint. For example, a 200 kHz transducer can have either a wide (20°) or narrow (3°) cone angle. A 24 kHz transducer may come with a standard 19° cone angle.

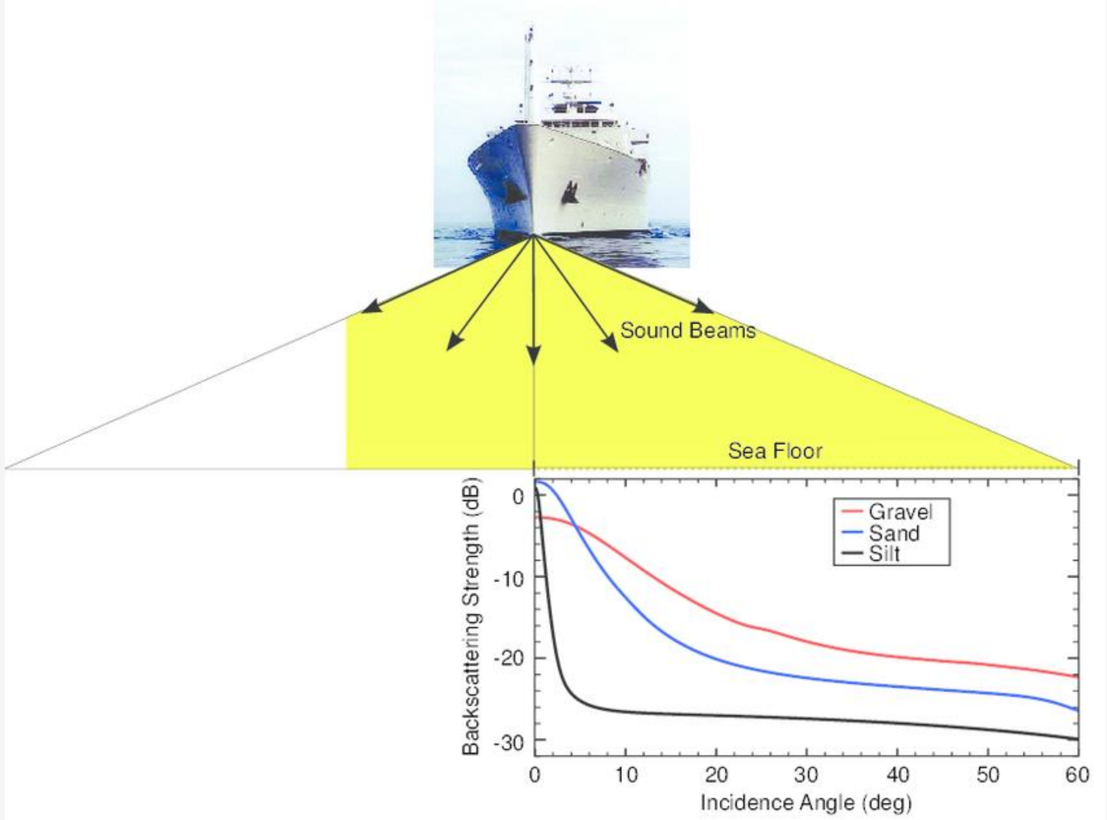
Manufacturers also produce ***dual frequency echosounders*** that use 2 separate transducers for high or low frequency operations.. Generally, it is better to use a wide cone angle for finding minimum soundings in shallow to medium depths, since the echosounder will record the first return. The narrow cone will show greater structural detail (spatial resolution) due to its narrow beam.



The depth capability of a sonar unit depends on its transmitter power, receiver, sensitivity, frequency, transducer, and transducer installation. Other things that effect depth capability include:

1. water conditions and type (in general, SONAR will show greater depth readings in fresh water than in salt water), and
2. bottom conditions (mud, gravel, morphology, etc.).

The backscatter of the sound pulse can also be analyzed to provide information regarding the nature of the seafloor (e.g., roughness, hardness). Regardless of the size of the footprint of the acoustic beam (which is a function of depth and transducer beam angle), only a single depth value is obtained for each acoustic pulse (or 'ping'). In the case of backscatter analysis, often the returns from a number of 'pings' are averaged to derive a value for the 'roughness' and 'hardness' of the seabed. The values obtained represent a single position below the ship, and thus single-beam surveys consist of a line of discrete points along the ship's track for which a number of parameters such as depth, hardness and roughness have been derived.



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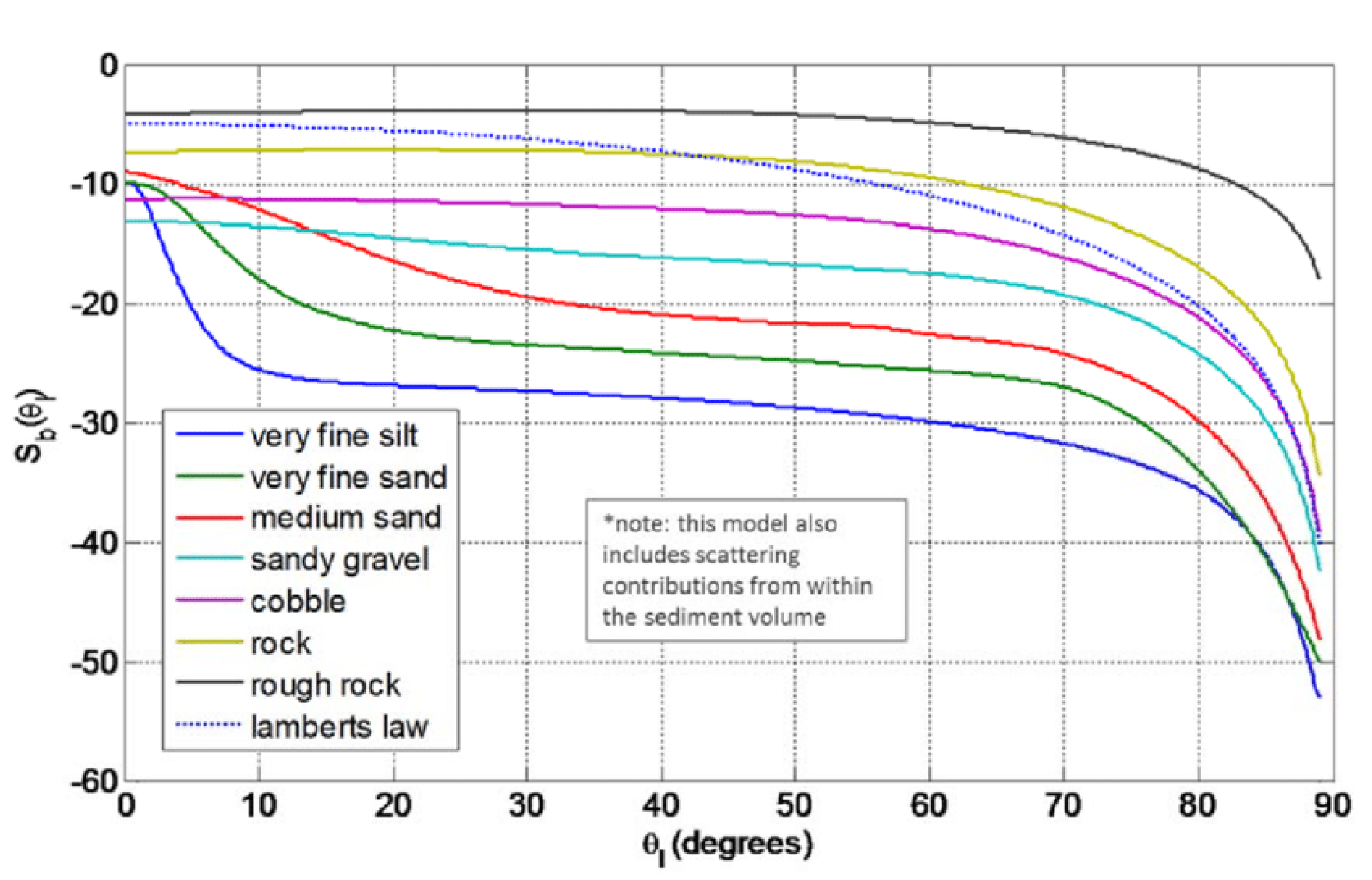
1. water conditions and type (in general, SONAR will show greater depth readings in fresh water than in salt water), and
2. bottom conditions (mud, gravel, morphology, etc.).



Example of angle-dependent backscatter for different substrate types at 100 kHz, based on model results using the APL-UW High-frequency Ocean Environmental Acoustic Models Handbook

Errors of the Echo Sounder

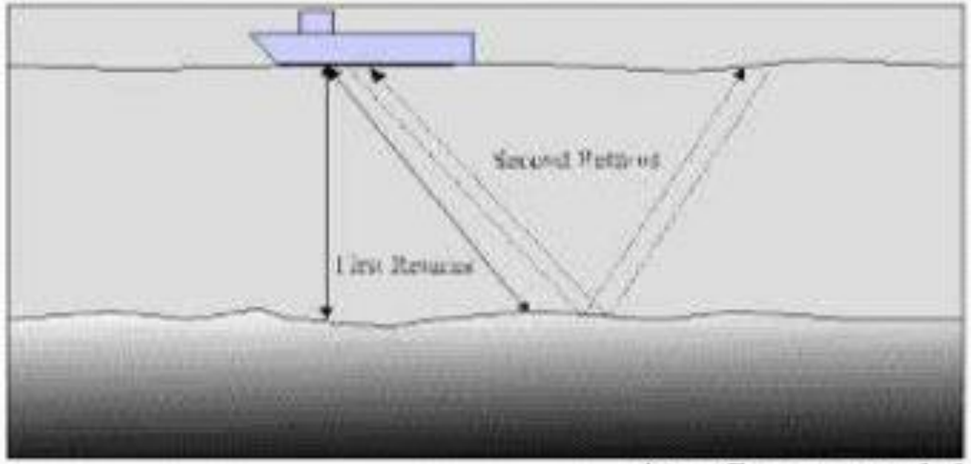
The velocity of propagation in water The velocity of acoustic wave changes if temperature, salinity or pressure changes and since velocity is not correct, the depth recorded will be inaccurate.

Stylus speed error: The stylus is rotating with a certain constant speed and the speed of the stylus that the time is taken for the stylus to travel from top to bottom is exactly equal to that for an acoustic pulse to travel twice the distance of the range selected. Due to the fluctuation in the voltage, the speed of the stylus motor changes hence the depth recorded Will be inaccurate. It should be checked periodically and adjusted as per the instruction is given in the manual.

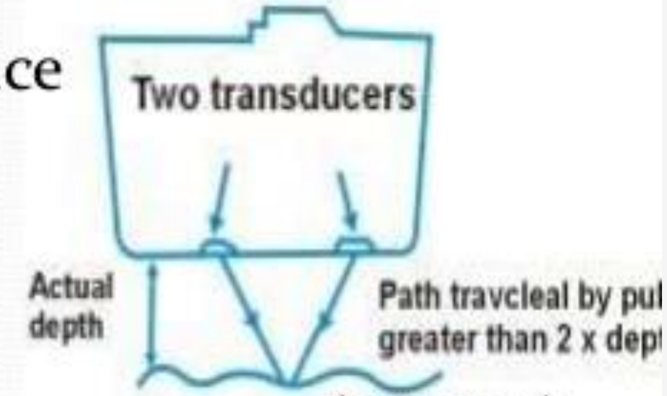
Multipath Echoes: The echo may be reflected a number of times between the keel and the seabed, thereby giving multiple depth marks on the record, in such case the first echo is the correct depth.
Pythagoras error: This error is found when two transducers are used one for transmission and other for reception.
Thermal and Density layer. The density of the water varies with temperature and salinity, which will tend to form different layers. It is possible for echoes to return from the surface of these layers and a faint line appears between zero and actual depth.
Zero line adjustment error If the zero adjustment is not correct, the depth recorded will not be correct.

ERRORS

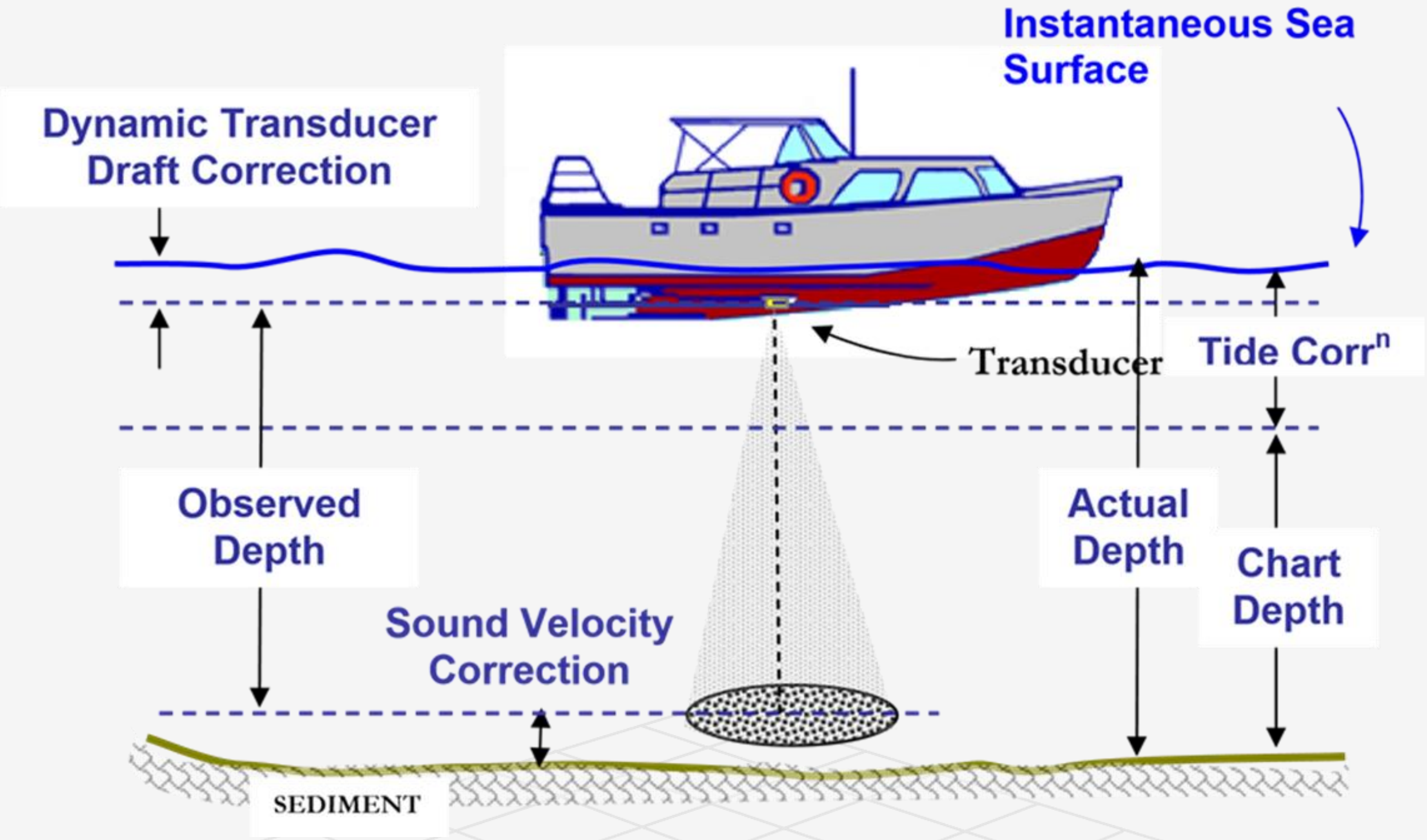
- Change in velocity of sound due to salinity changes of seas
- Bubbles and aeration causes errors
- Multiple echoes in shallow waters
- Pythagoras error and slanted distance



(Seafloor.otterlabs.org)

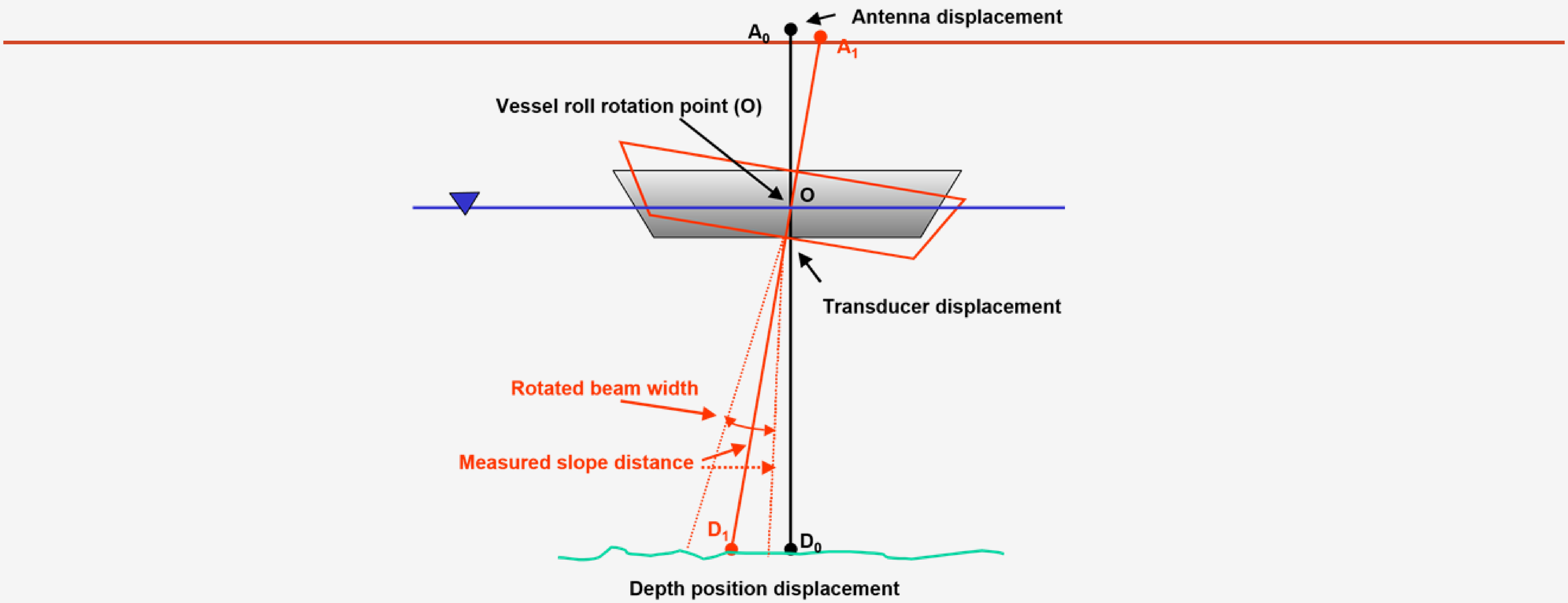


(cram.com)



Instantaneous Sea Surface
Dynamic Transducer Draft Correction
Transducer
Tide Corr^n
Observed Depth
Actual Depth
Chart Depth
Sound Velocity Correction
SEDIMENT

Stablility

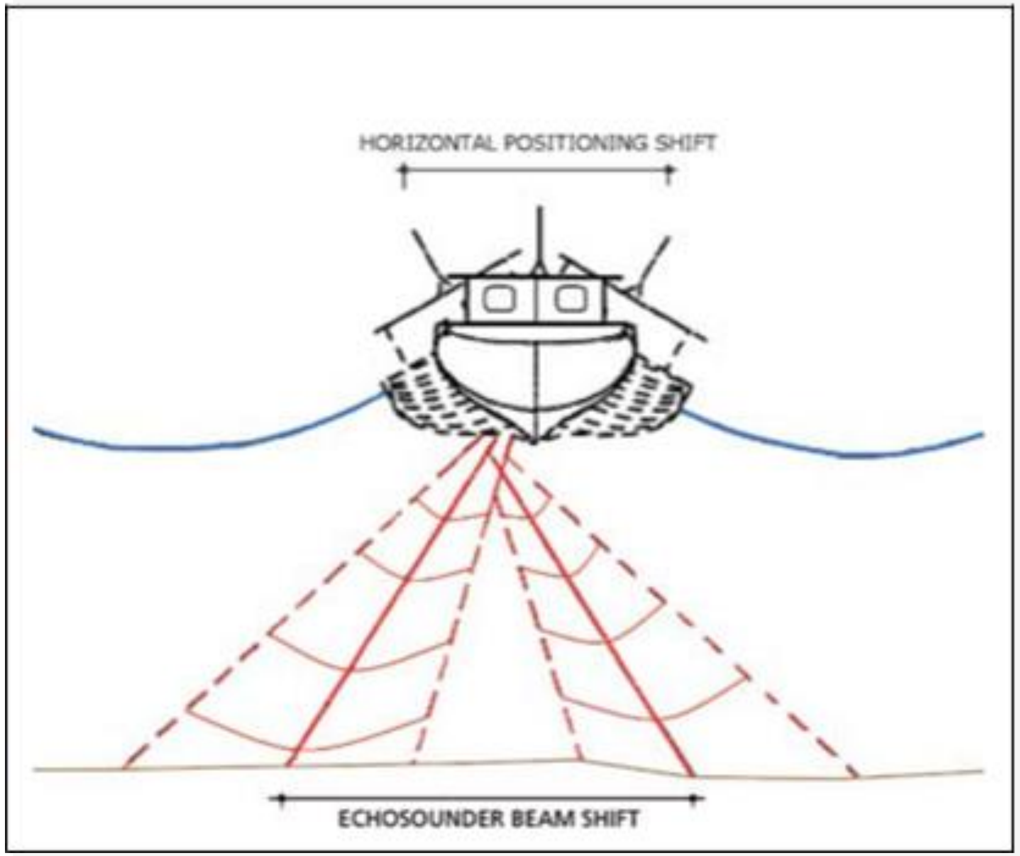


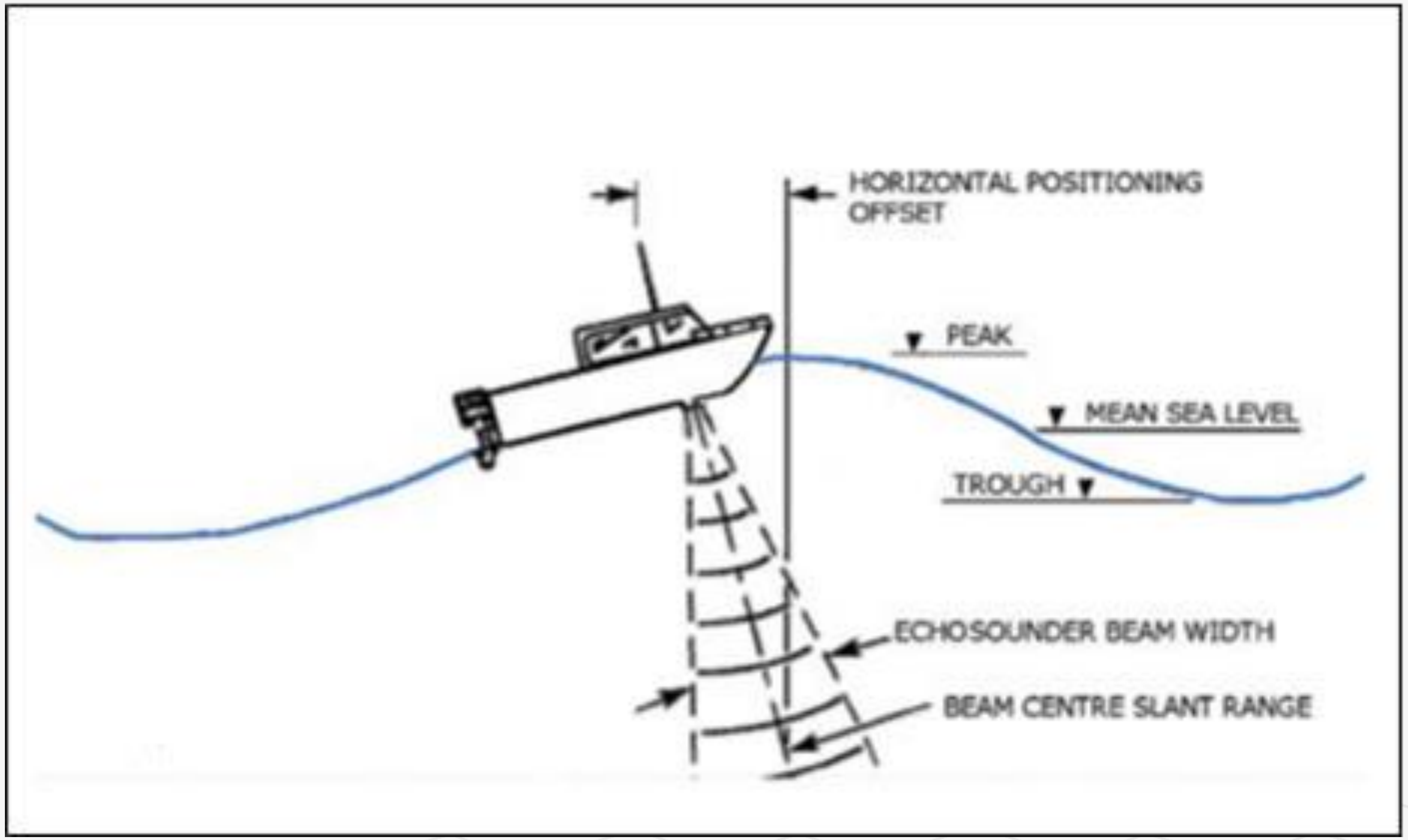
Depth correction due to roll @ pitch

EFFECTS OF VESSEL ROLL PITCH AND HEAVE

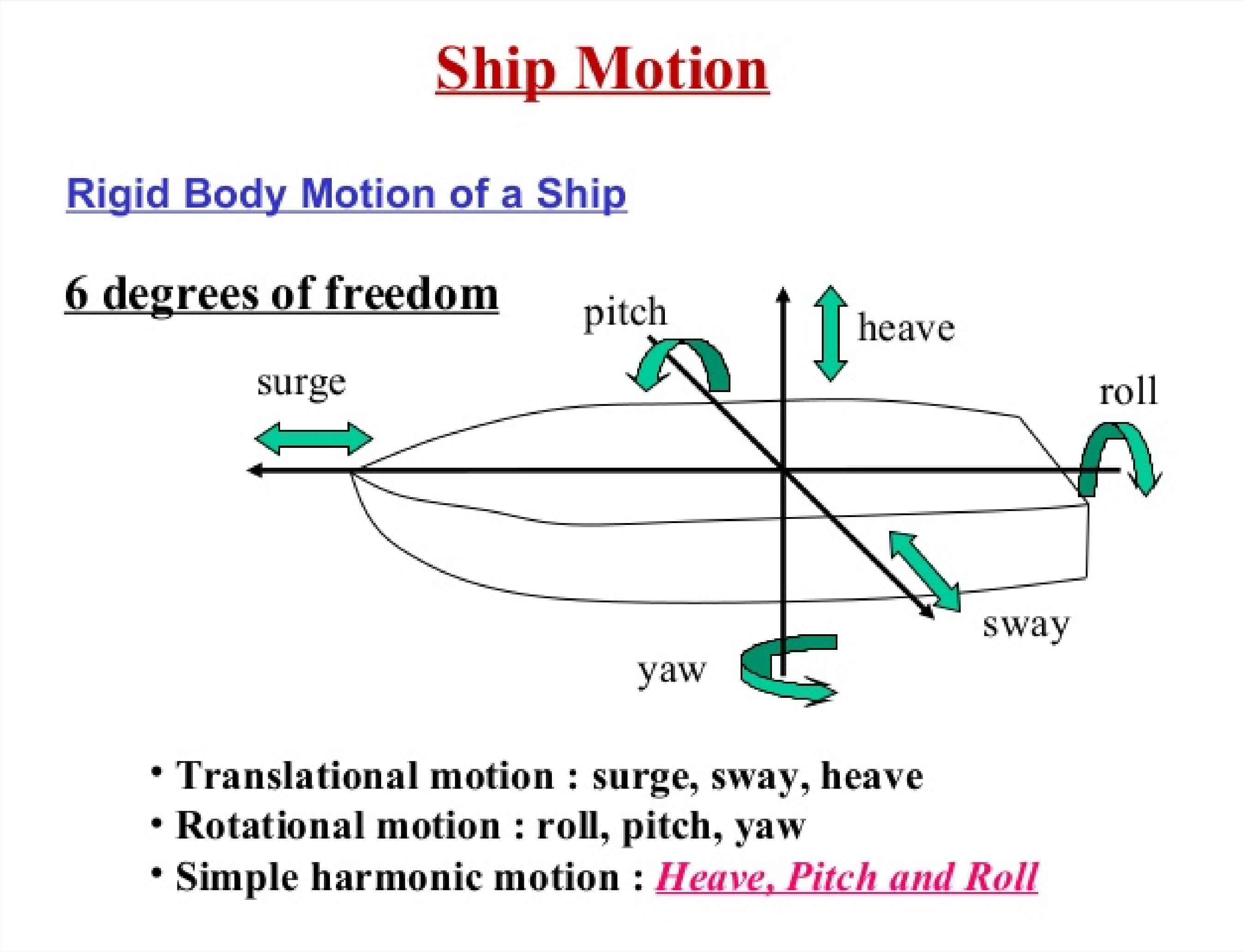
Correcting observed depths for the superimposed effects of vessel roll, pitch and heave is perhaps the most difficult aspect of hydrographic surveying since all three conditions can occur simultaneously and at different periods. Roll and pitch introduce bias error in depth, resulting in a deeper reading over a level bottom .

On side-mounted transducers, this bias error is compounded by the random up and down motion (heave) of the vessel. Unless reliable motion compensation devices are used, the only practical method of minimizing vessel motion effects is to limit the maximum allowable sea states under which a particular class of survey may be performed.


HORIZONTAL POSITIONING SHIFT
ECHOSOUNDER BEAM SHIFT


HORIZONTAL POSITIONING OFFSET
PEAK
MEAN SEA LEVEL
TROUGH
ECHOSOUNDER BEAM WIDTH
BEAM CENTRE SLANT RANGE

Unlike land surveys that use static or stationary equipment to conduct measurements, bathymetry involves a dynamic ship that is moving while carrying out observations. Thus, special allowances have to be made for any error that arises out of this motion.

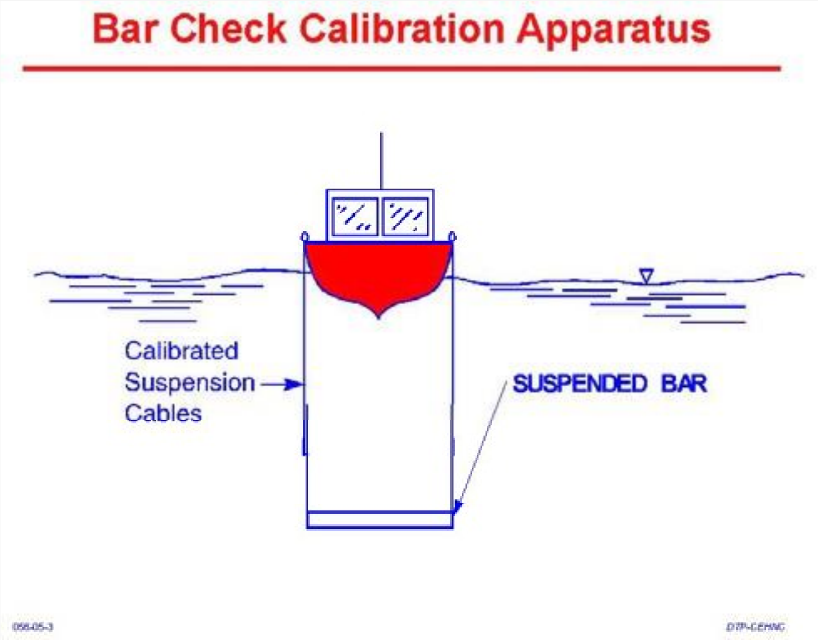


Equipment Calibration

Equipment calibration is a critical element of hydrographic surveying. From the smallest and simplest platforms to large surveying ships, it is critical that all equipment is properly calibrated. Calibration includes the measurement of offsets between all peripheral equipment.

The BAR CHECK is a mandatory calibration procedure that should be performed prior to any critical survey as well as on a regular basis. This applies to both Single and Multi Beam surveys. There are different methods for completing a bar check. If a velocity probe is available, a velocity cast is taken. A bar or plate is then suspended in the water a known distance below the transducer. Correcting for draft, the distance reported by the echosounder is compared to the known distance. The velocity probe should also be tested by taking readings in distilled water of a known temperature and comparing the readings to theoretical readings.

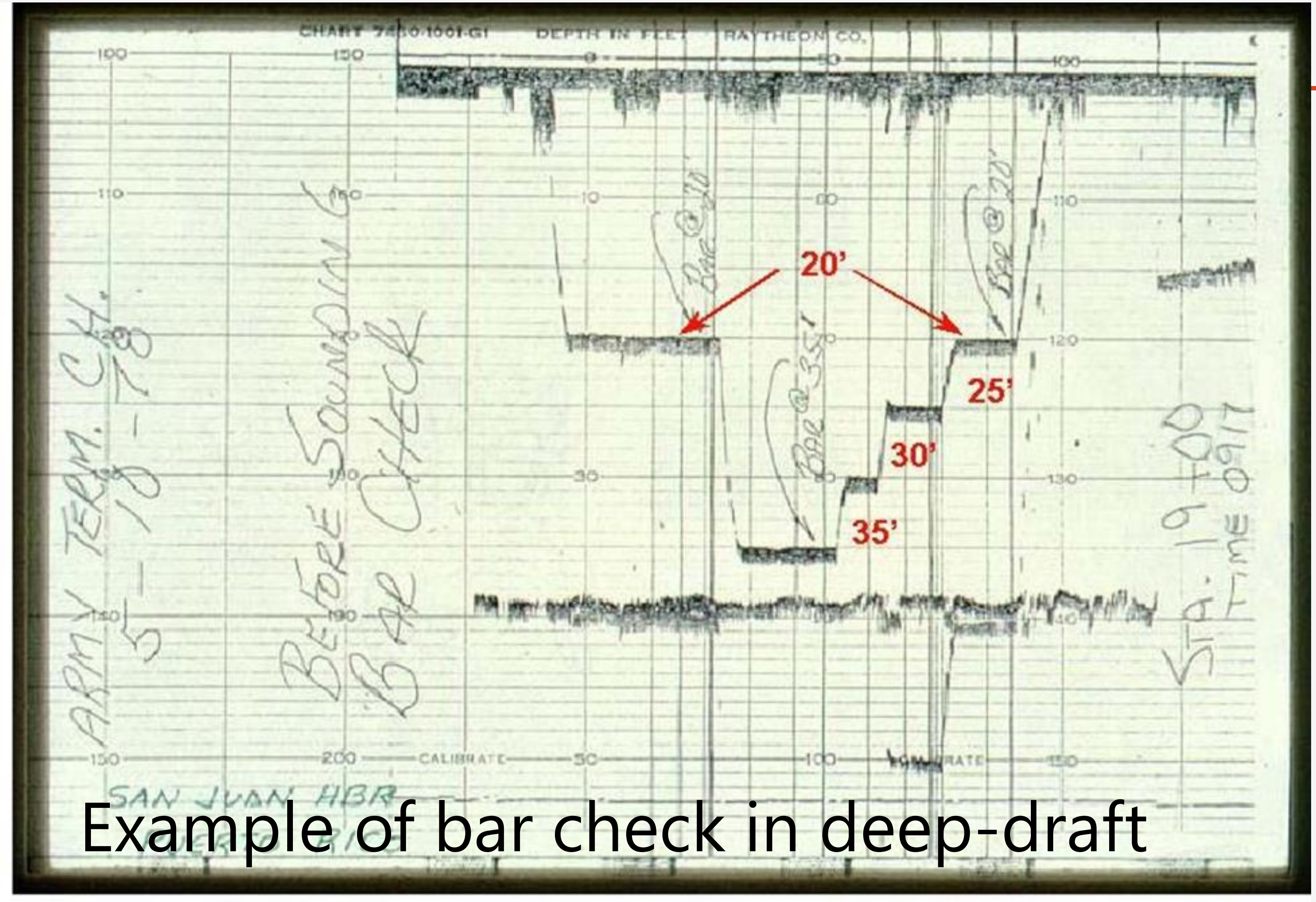
Calibration of acoustic sounding instruments is absolutely critical (and mandatory) in maintaining quality control of depth measurements



All navigation and dredging surveys for contract measurement and acceptance require, as a minimum, twice daily calibration at the project work site. Failure to perform adequate calibrations, including documentation/certification thereof, can lead to total unacceptance of the survey and any payment associated with it.

Calibration of acoustic sounding instruments is absolutely critical (and mandatory) in maintaining quality control of depth measurements. This is primarily due to instabilities or variances in the water column, or to a lesser extent, in the equipment. All navigation and dredging surveys for contract measurement and acceptance require, *as a minimum*, twice daily calibration at the project work site. Failure to perform adequate calibrations, including documentation/certification thereof, can lead to total unacceptance of the survey and any payment associated with it. This section describes the various methods used to calibrate single beam depth measurement equipment. The calibration procedures in this section also apply to multiple transducer sweep systems and, to a lesser extent, multibeam systems. Independent quality assurance procedures are also detailed.

Bar check calibration. The primary depth calibration procedure used is the "bar check." The bar check is recognized throughout the Corps and dredging industry as the standard reference system for acoustic depth measurements. The bar check is a quality control procedure. It is not a quality assurance procedure. The bar check is a flat bar or plate suspended by two precisely marked lines to a known depth below the water surface and under the transducer. A series of depth intervals are observed during a bar check, down to the project depth. Any difference between the reference bar depths and the recorded depths represent corrections to be made to any subsequently recorded soundings.



Example of bar check in deep-draft

Tidal Effects - Datum

Fundamentals of Ocean Tides

Fundamentals of Ocean Tides

Oceanic tides result from the gravitational pull of the moon, the sun, and the planets and from local meteorological disturbances. The tide is the alternating rise and fall in sea level (or water surface of a tidal lake of creek) produced by the gravitational force of the moon and the sun. Other non astronomical factors, such as a meteorological forces, bathymetry, coastline configuration also play an important role in shaping the tide

The planes of the moon's orbit around the earth and the earth orbits around the sun are nearly parallel. It takes 24 lunar hours or solar hours for the earth to expose the same point to the moon or the sun. During this time interval, the bulge of tidal forces will pass twice through this point.

4. Water Level -Tides and tidal

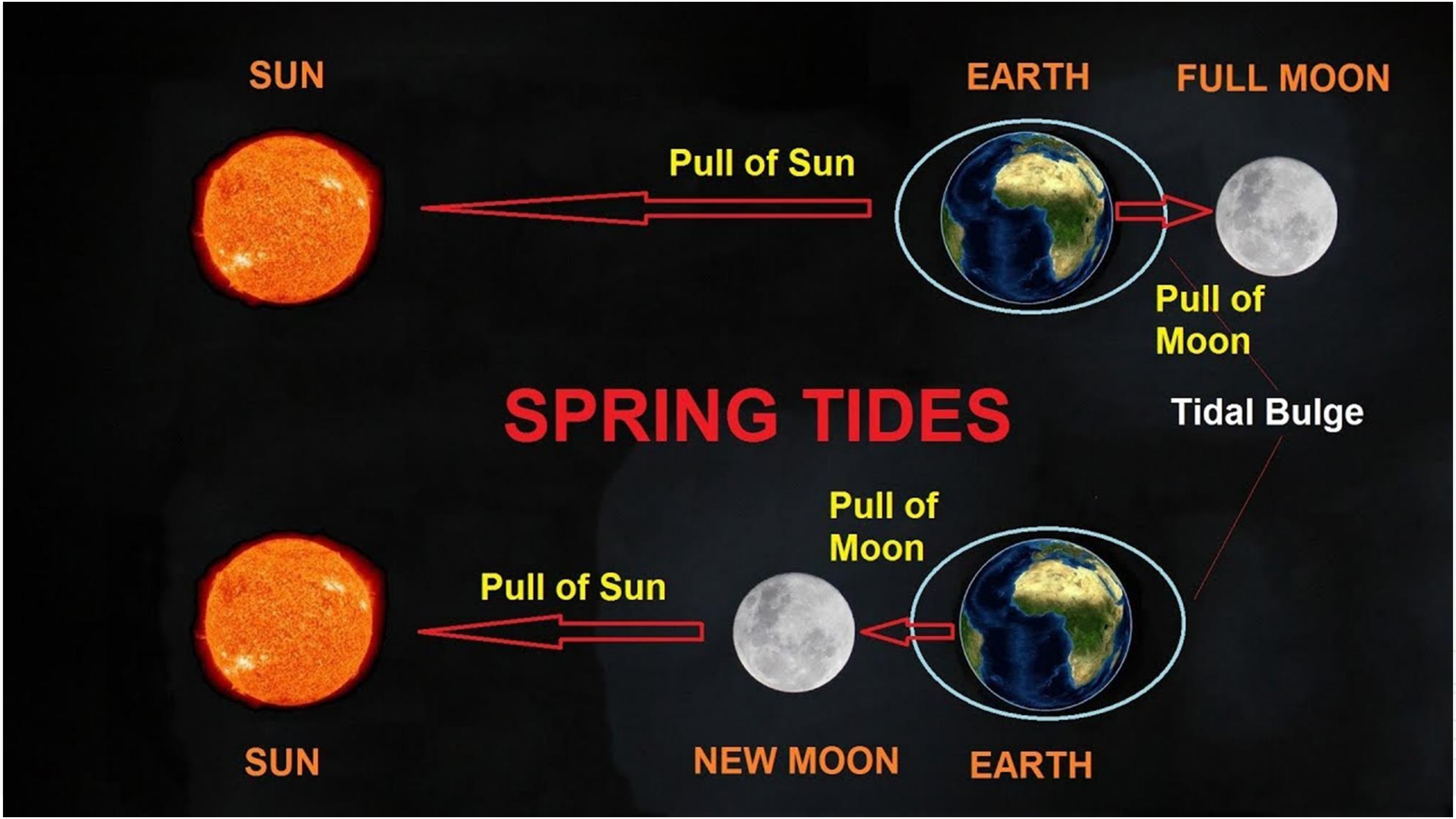
Introduction

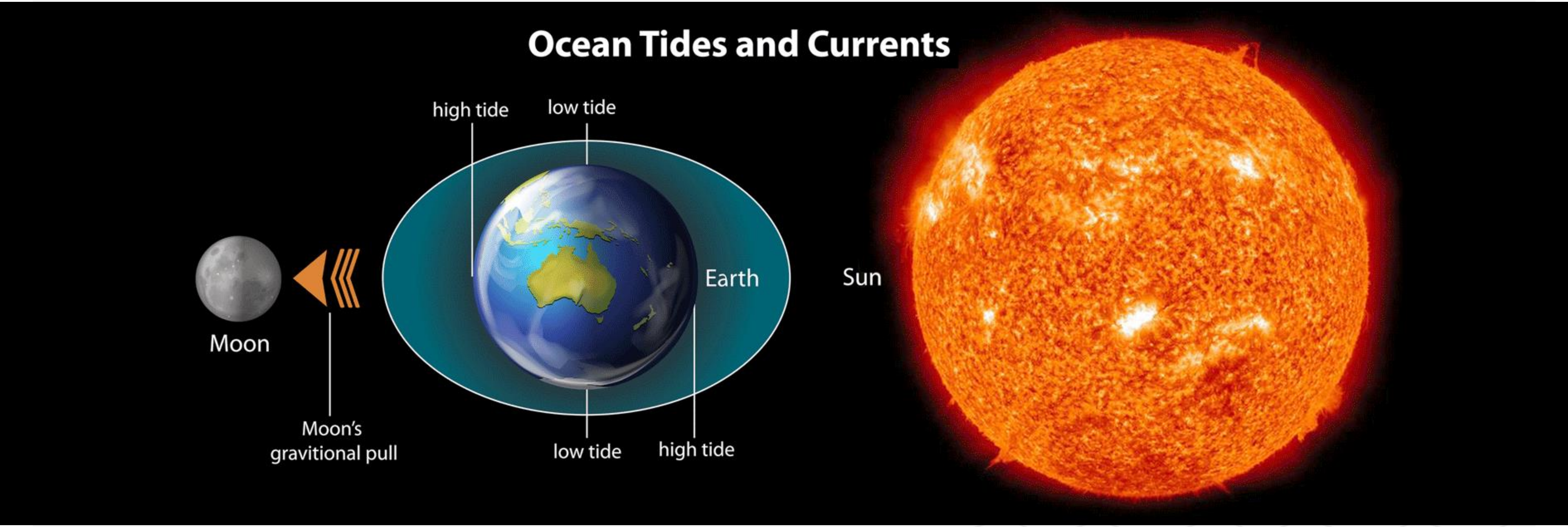
An ocean tide is a periodic motion of water due to the differential gravitational forces of celestial bodies (mostly Moon and Sun) upon different parts of the rotating Earth. Due to greater distance the effect of the Sun is only 46% of that of the Moon. The tide is most commonly observed as the vertical rise and fall of the sea level and has an average period of 12.4 hours (24.8 hours in some places). The prime phenomenon is however the *horizontal tidal current*. A tidal current is a horizontal water movement that builds up in vertical rises and falls along the coastlines. Tides and tidal currents are intimately related and parts of the same phenomenon, caused by tide-producing forces of Moon and Sun.

The astronomical origin of tides

Definition: tide - from the sailor's perspective - is the vertical rise and fall of the sea level surface caused primarily by the change in gravitational attraction of the moon, and to a lesser extent the sun.

The earth is also in orbit around the sun (one revolution in one year) creating not only another centrifugal force but also a gravitational interaction. These two yield a bulge on the night site (centrifugal) and a bulge on the day site (gravitational) both of them moving as the world turns. Therefore, a certain place on this world will experience two high and two low tides each day.


SUN
EARTH
FULL MOON
Pull of Sun
Pull of
Moon
SPRING TIDES
Tidal Bulge
Pull of
Moon
Pull of Sun
SUN
NEW MOON
EARTH



Ocean Tides and Currents
high tide
low tide
Earth
Sun
Moon
Moon's
gravitional pull
low tide
high tide

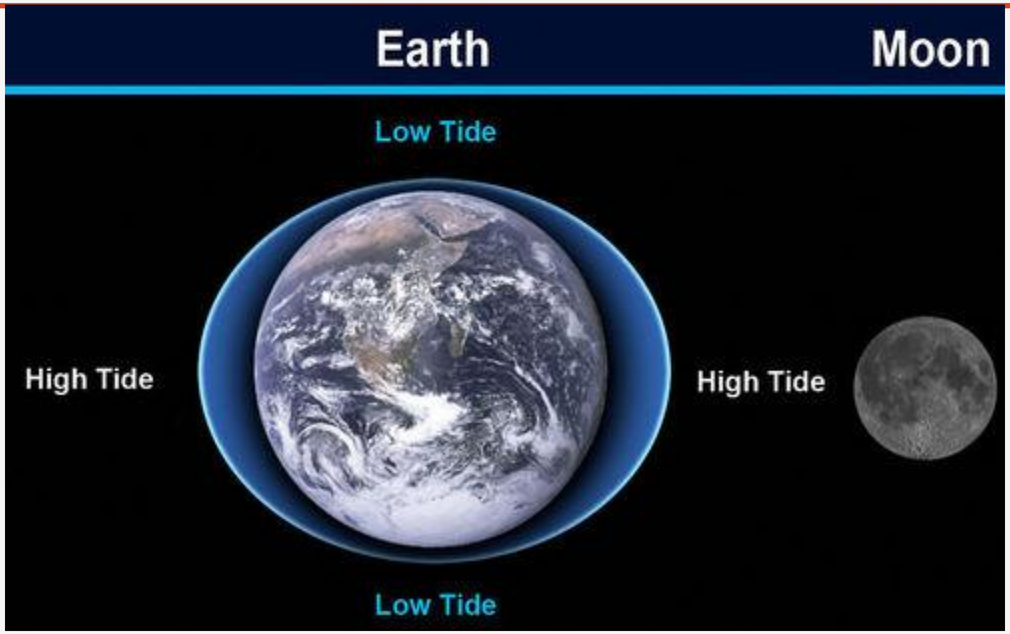
High Tide and Low Tide

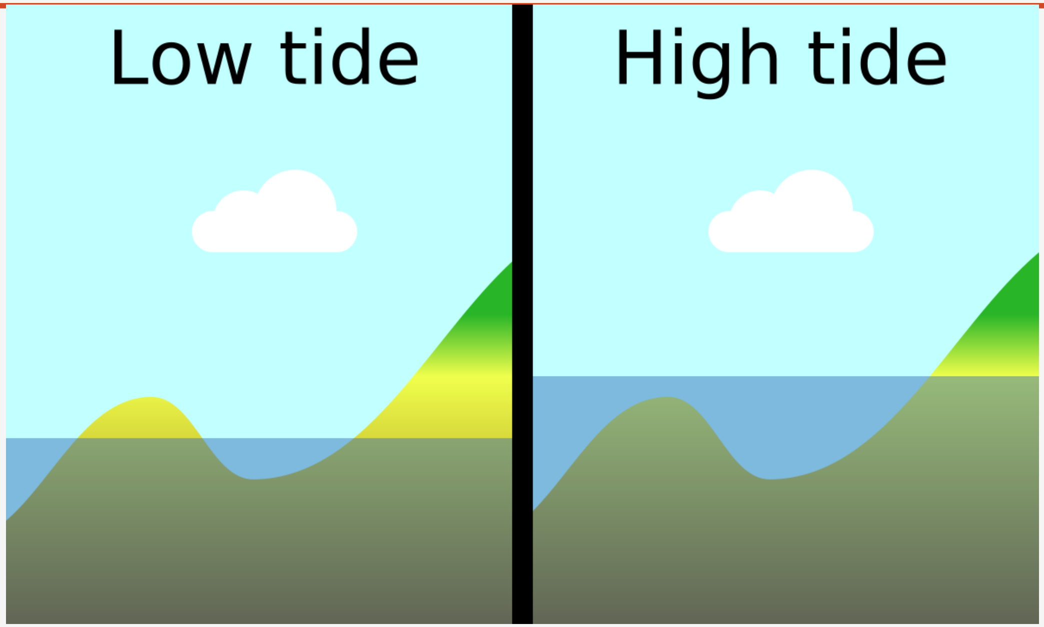
Because the moon is closer to the earth than the sun, it has the most influence on the tides. In fact, it's fair to say that tides would not occur if the earth and the moon were not attracted to each other. Of course, I'm not referring to a love/hate type of attraction but rather the gravitational attraction between the two bodies. The gravitational pull of the moon causes the oceans and other major water bodies to bulge out toward the moon.

When the gravitational pull is at its highest point, the result is high tide, which is the highest level of the tide. When the pull is at its lowest point, we see low tide, or the lowest level of the tide. The earth itself is also pulled toward the moon but with less strength. This pulls the earth away from the water on the opposite side of the earth, making the water on that side bulge as well. Therefore, high tide occurs on both sides of the planet at the same time. Meanwhile the earth is rotating. So, we experience tides throughout the day.

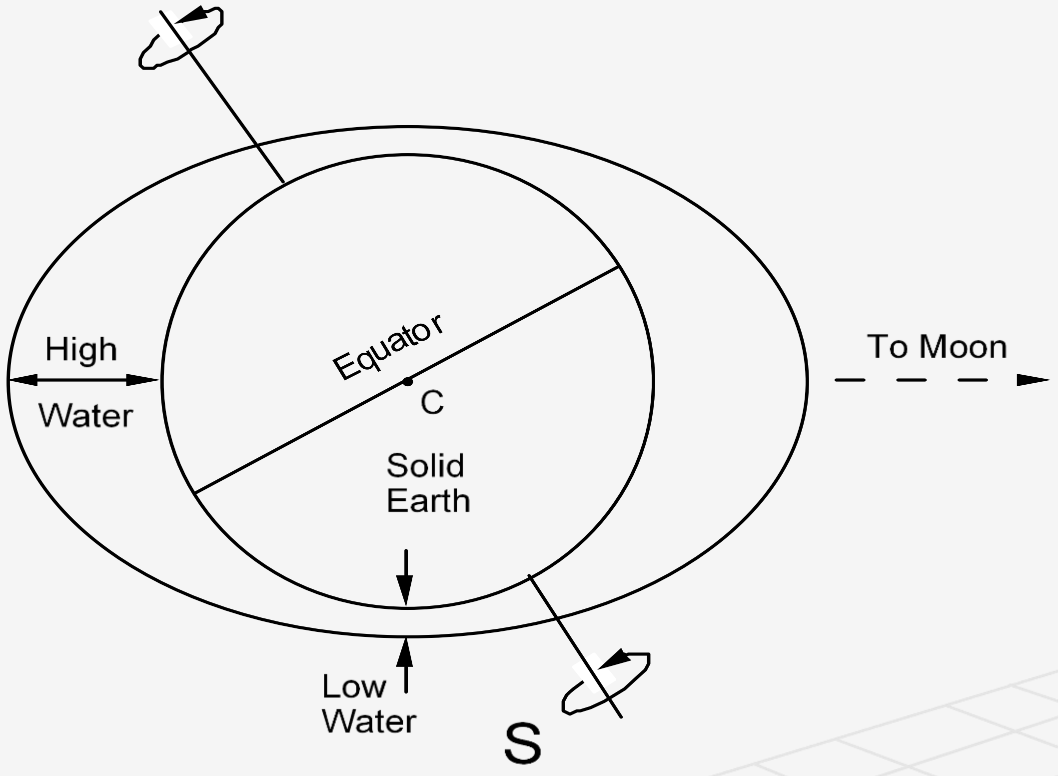
Tidal Datums

Definition: A plane of reference derived from rise/fall of oceanic tides.





Datums relative to a specific time (i.e., Epoch 18.6 years) can be determined; located on the ground and mapped. Datums can be determined by observations when needed (i.e., settle dispute,mengineering projects, or scientific investigation). Tidal Datum (TD) are used for engineering projects, coastal boundary delineation, and nautical charting



High and low tides in Earth-Moon system.

With a rotating Earth, the Moon transits every 24h50m. During that interval, two high tides and two low tides occur at any point on the Earth's surface.

When the Moon is in the plane of the equator, the forces are equal in magnitude at the two points on the same parallel of latitude and 180° apart in longitude. When the Moon declination is North or South, the forces are unequal at such points and tend to cause an inequity in the two high waters and the two low waters of a day.

The tidal effect of the Moon is more than twice that of the effect of the Sun, although the mass of the Moon is a very small fraction of the Sun's mass. This is due to the fact that the Moon is much closer to the Earth and the differential forces vary inversely as the cube of the distance.

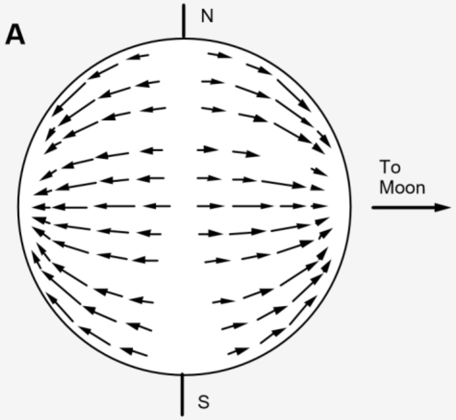
The tides depend on the geometrical configuration of the Earth-Moon-Sun system.

Two special cases occur when the Earth, Moon and Sun are approximately on the same line, which correspond to new and full Moon (spring tide), and first and third quarters of the Moon (neap tide),

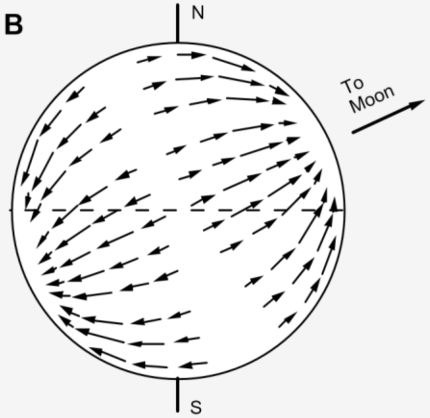
Spring tide occurs at times of new and full Moon when the Sun, Moon and Earth are in line. The tractive forces are acting in the same direction, and the resulting tide is a higher tide.

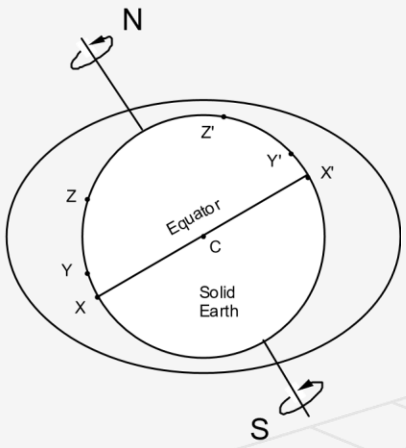
Neap tide occurs at times of first and third quarter of the Moon when the tractive forces due to the Sun and the Moon are at right angles to each other, and the resulting tide is lower than average.

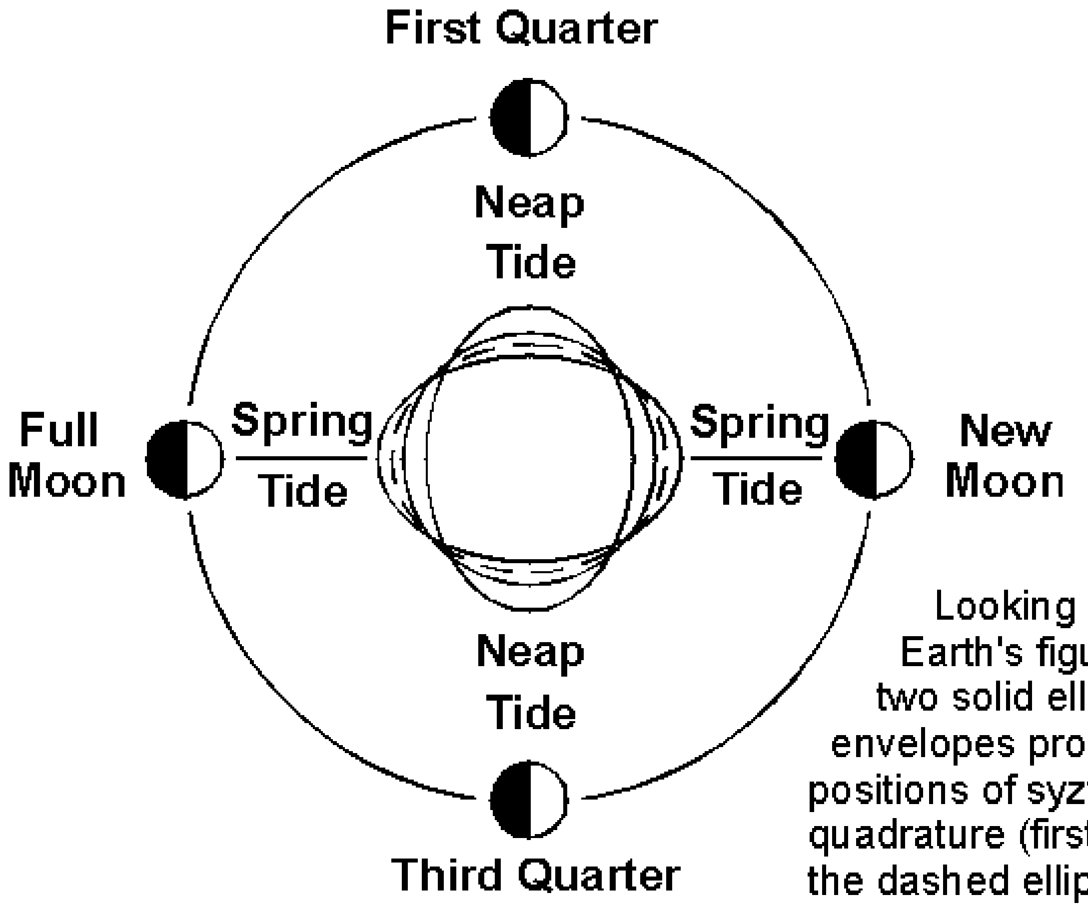
A



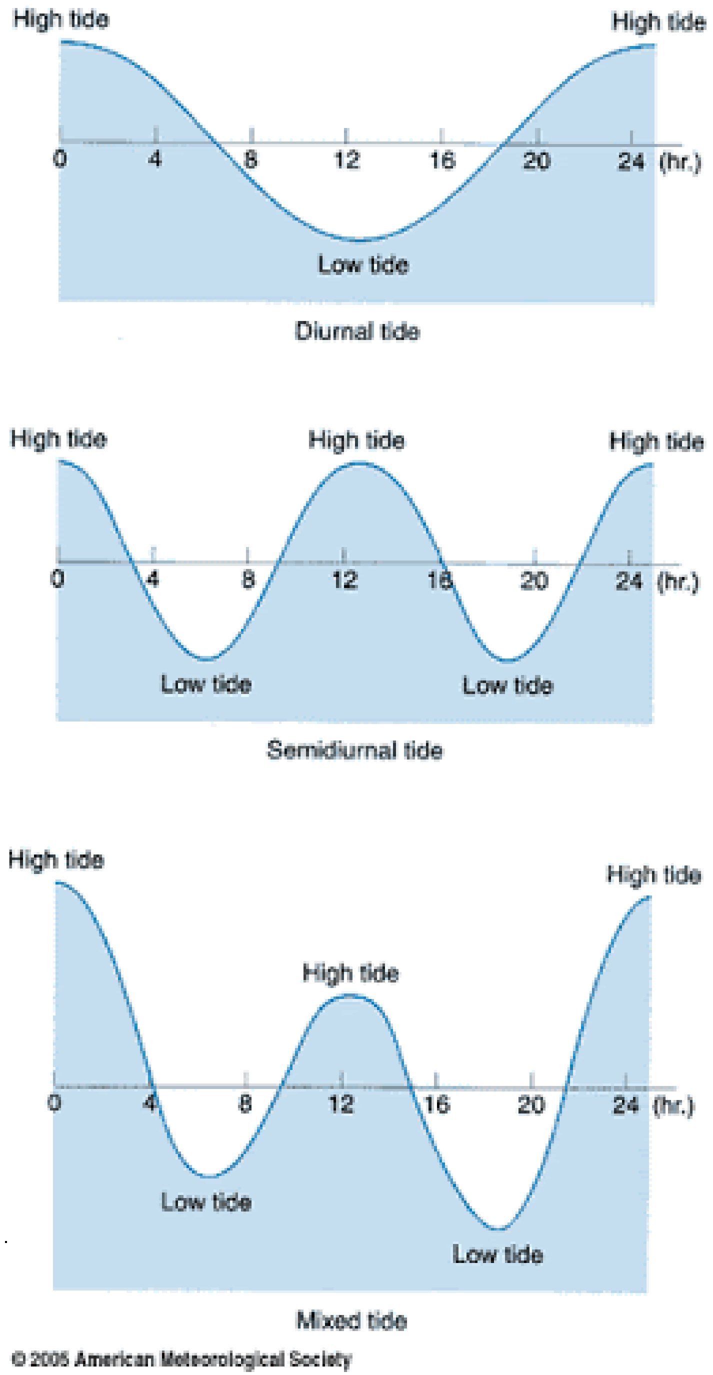
B





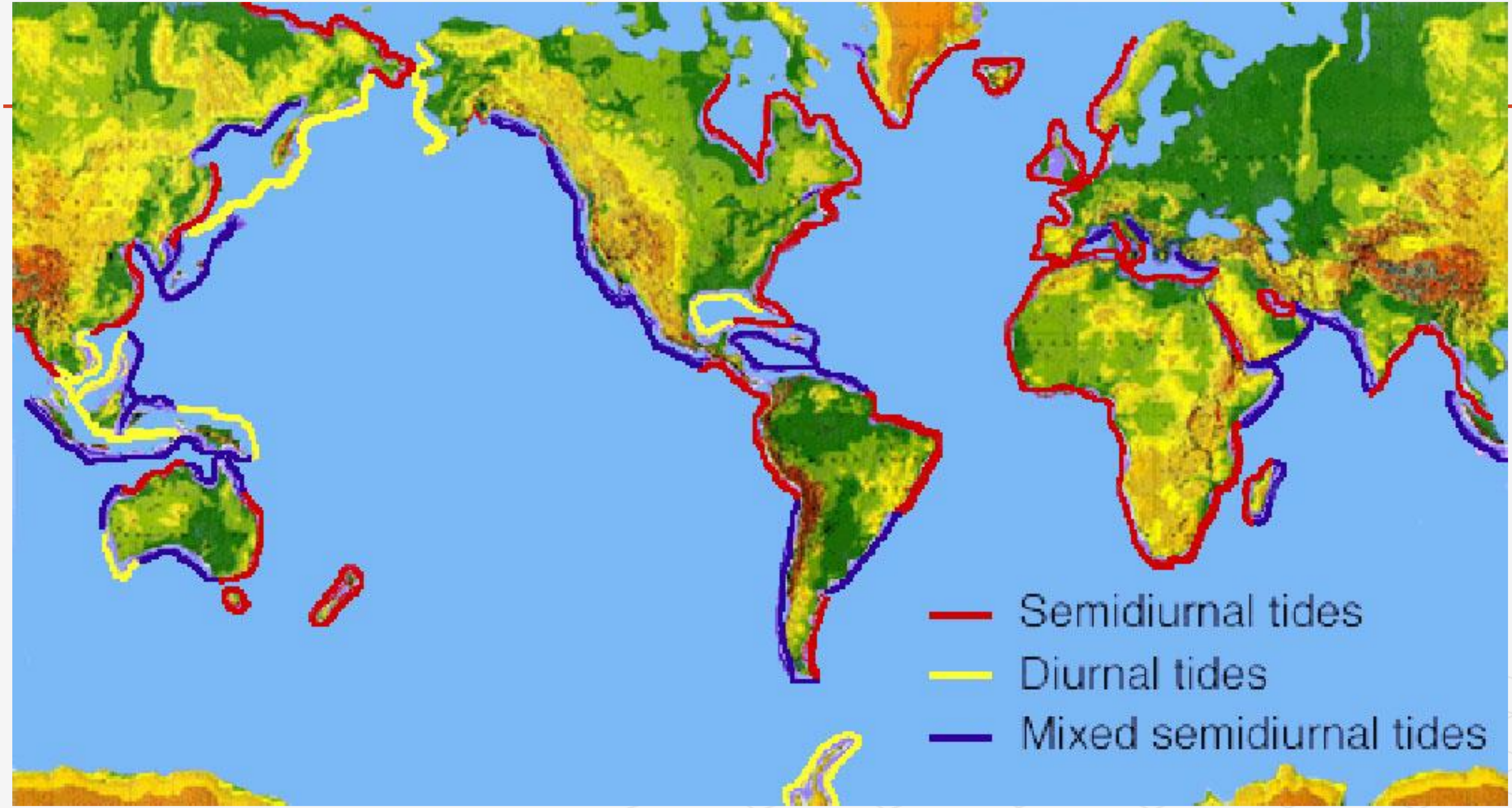


Looking down on the north pole of the Earth's figure (central solid circle). The two solid ellipses represent the tidal force envelopes produced by the Moon in the positions of syzygy (new or full moon) and quadrature (first and third quarter), respectively; the dashed ellipse shows the smaller tidal force envelope produced by the Sun.



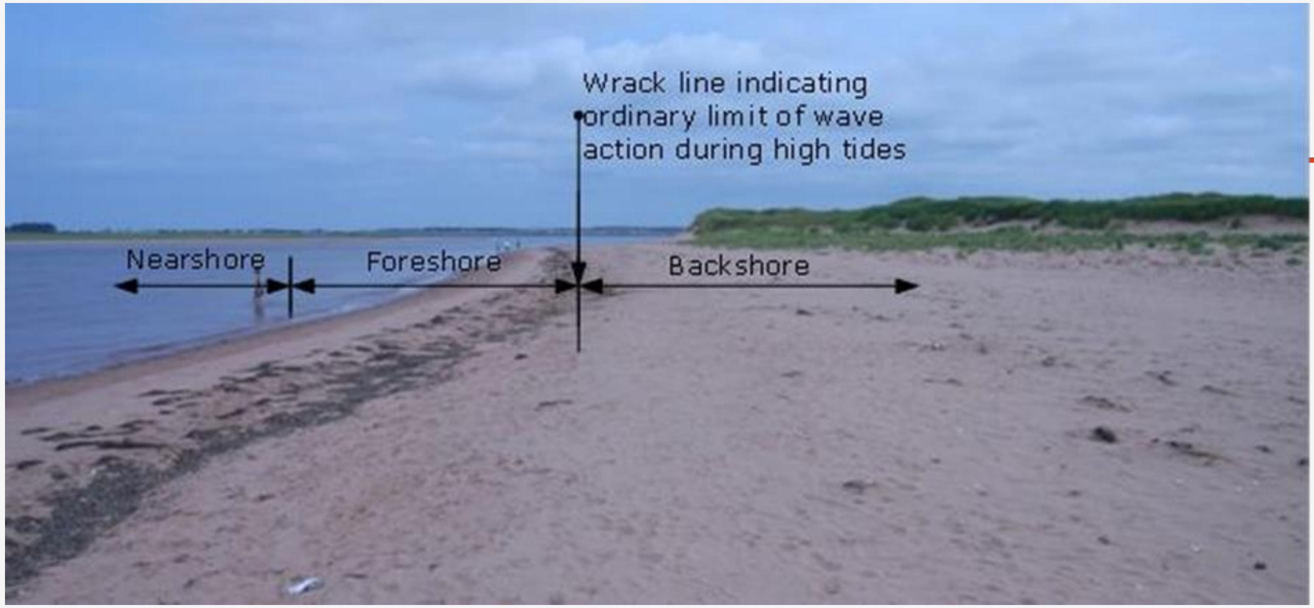
Four classes of tides can be distinguished:

- ***Diurnal*** (D): only one HW (High Water) and one LW (Low Water) each lunar day.
- ***Semi-Diurnal*** (SD): two nearly equal HW's and two nearly equal LW's approximately uniformly spaced over each lunar day.
- ***Mixed*, *Mainly Diurnal*** (MD): either two unequal HW's and LW's at irregular spacing over a lunar day, or only one HW and one LW in a day.
- ***Mixed*, *Mainly Semi-Diurnal*** (MSD): two HW's and two LW's each lunar day, with irregular height and time intervals.


Semidiurnal tides
Diurnal tides
Mixed semidiurnal tides

Field Measurements

Many hydrographic projects require preliminary analysis of site condition related to the shoreline and tides. ***Tidal waters in estuaries have a different behavior than tides at coastal tide stations where the coastal shoreline if fairly uncomplicated***. However there are a few general measurement strategies that apply equally to field measurements for tidal studies at the open coastal waters tide stations and for tide ion estuaries



Wrack line defining limit of foreshore

The ***nearshore*** is defined here as the seabed extending seaward from the beach at mean sea level offshore to the limit of influence of wave action.

The ***foreshore*** extends from the beach at mean sea level up to the ordinary limit of wave action during high tides . This area is generally void of vegetation. Its landward limit can often be identified by the wrack line or the upper limit of kelp, driftwood and other debris along the shore

The ***backshore*** extends from the ordinary limit of wave action at high tides landward to the limit of influence of coastal processes – typically to level, stable land away from the cliff face of the landward limit of sand dunes.

Datum

Datum is an imaginary level surface or level line from which the vertical distances of different points are measured. In Malaysia the datum adopted for the great trigonometrical survey is the mean sea level at Port Klang. Why Port Klang?

Bench mark is a permanent mark / fixed point of known RL with reference to the datum line established on a field to use as a reference point. A benchmark can be a concrete base in which an iron bar is fixed, indicating the exact place of the reference point.

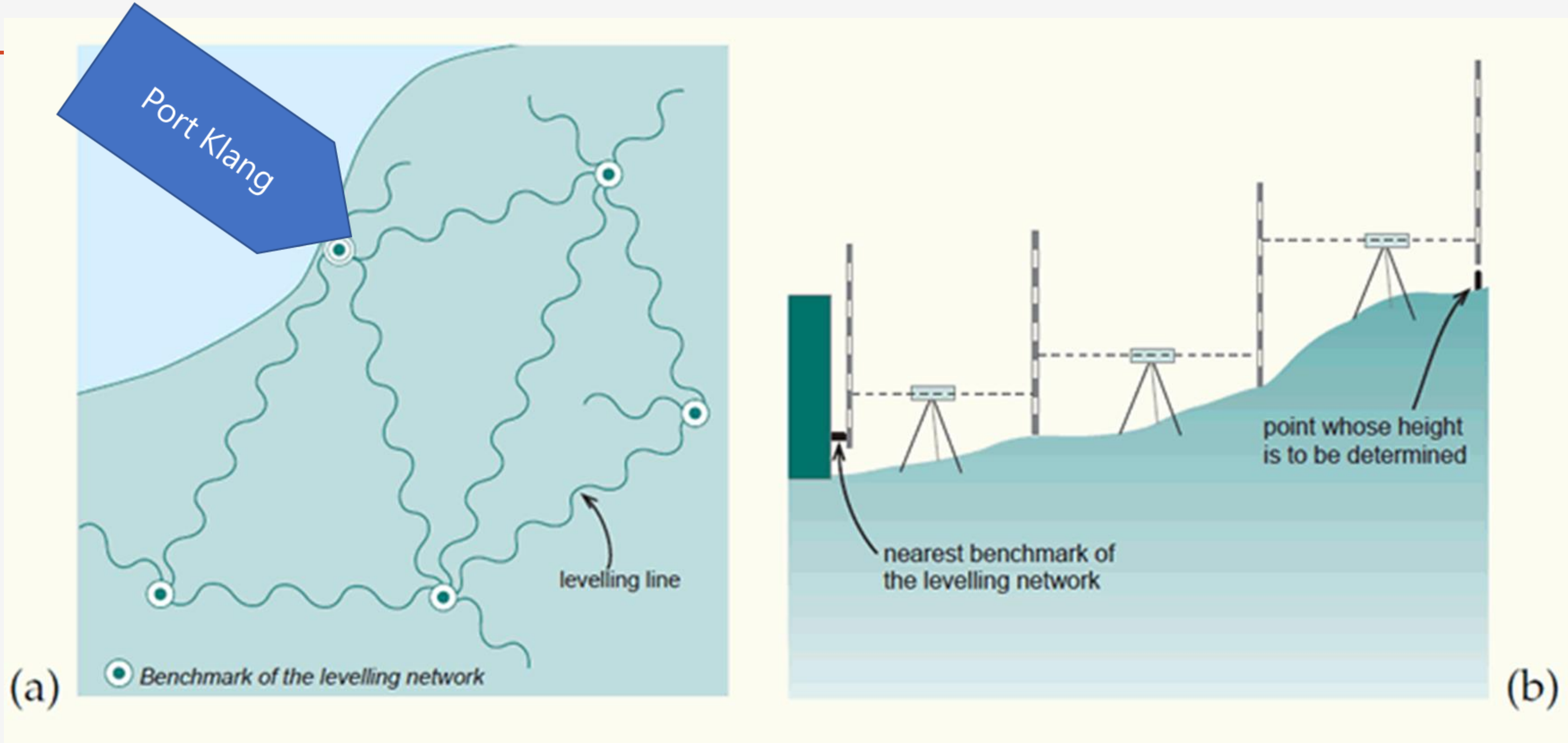
While a Reduced level is the vertical distance between a survey point (Point of interest) and the adopted level datum.

Reduced level can also be defined as:

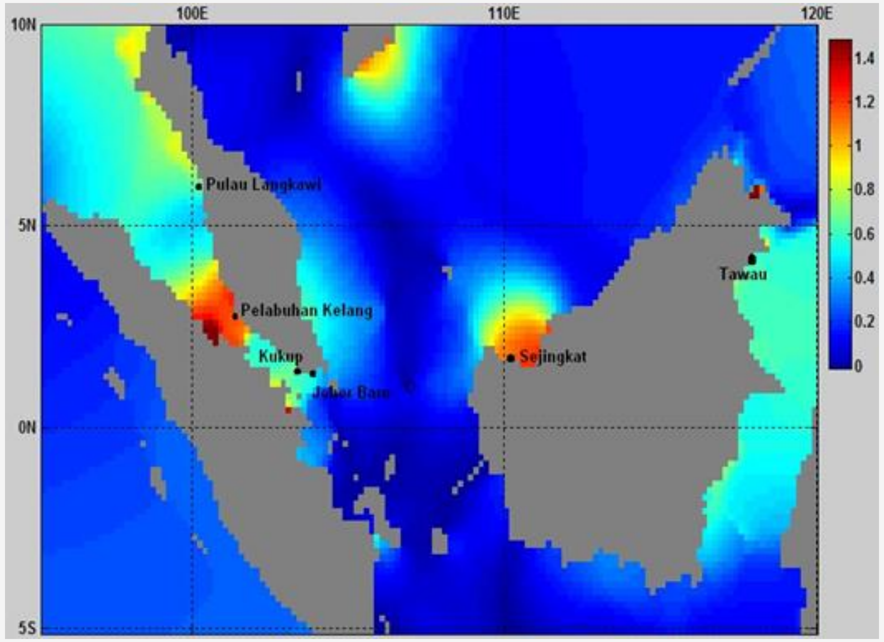
The vertical distance of a point above or below the datum line is known as the reduced level of that point. The RL of a point May be positive or the negative according as the point is above or below the datum

The elevation of point relative to the Mean Sea Level is called the reduced level (RL) .

Vertical Datum



Types of tides available in Malaysia

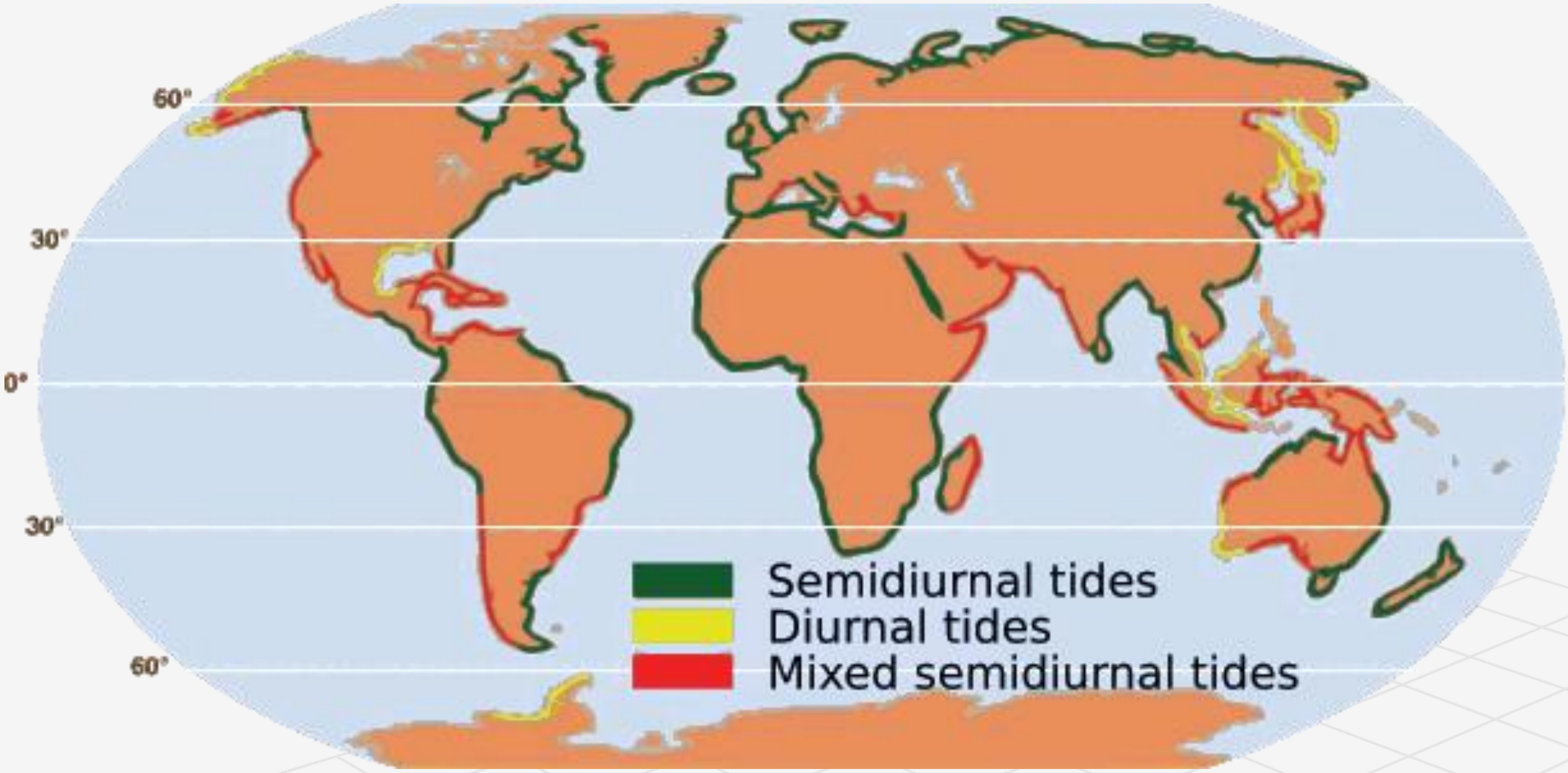


Six Sites Around Malaysia with the Highest Tidal Range - (a) Sejingkat; (b) Pelabuhan Kelang; (c) Pulau Langkawi; (d) Tawau; (e) Kukup; and (f) Johor Baru

Types of tidal cycles

Three different tidal patterns - unlike the idealized sinusoid curve pictured above, with two equally proportioned high and low tides every lunar day –
can be found on Earth since our planet isn't a perfect sphere without vast continents.

1. Semidiurnal
2. Diurnal
3. Mixed semidiurnal



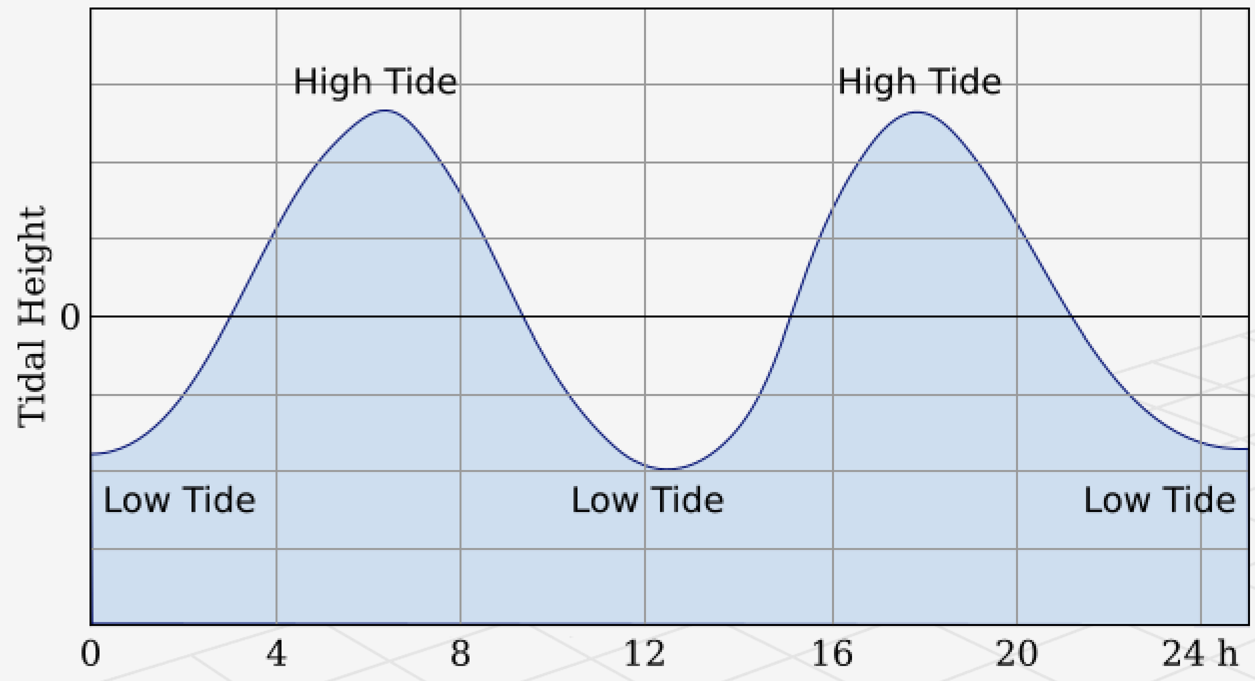
Semidiurnal tide

A semidiurnal tidal cycle consists of two nearly equal high tides and two nearly equal low tides within the lunar day. The tidal period is 12 hours and 25 minutes: from high tide to the next high tide. If the planet was covered entirely with water and without any continents obstructing the free motion of water, semidiurnal cycles would be default.

Most of the world's coastlines have semidiurnal tides.

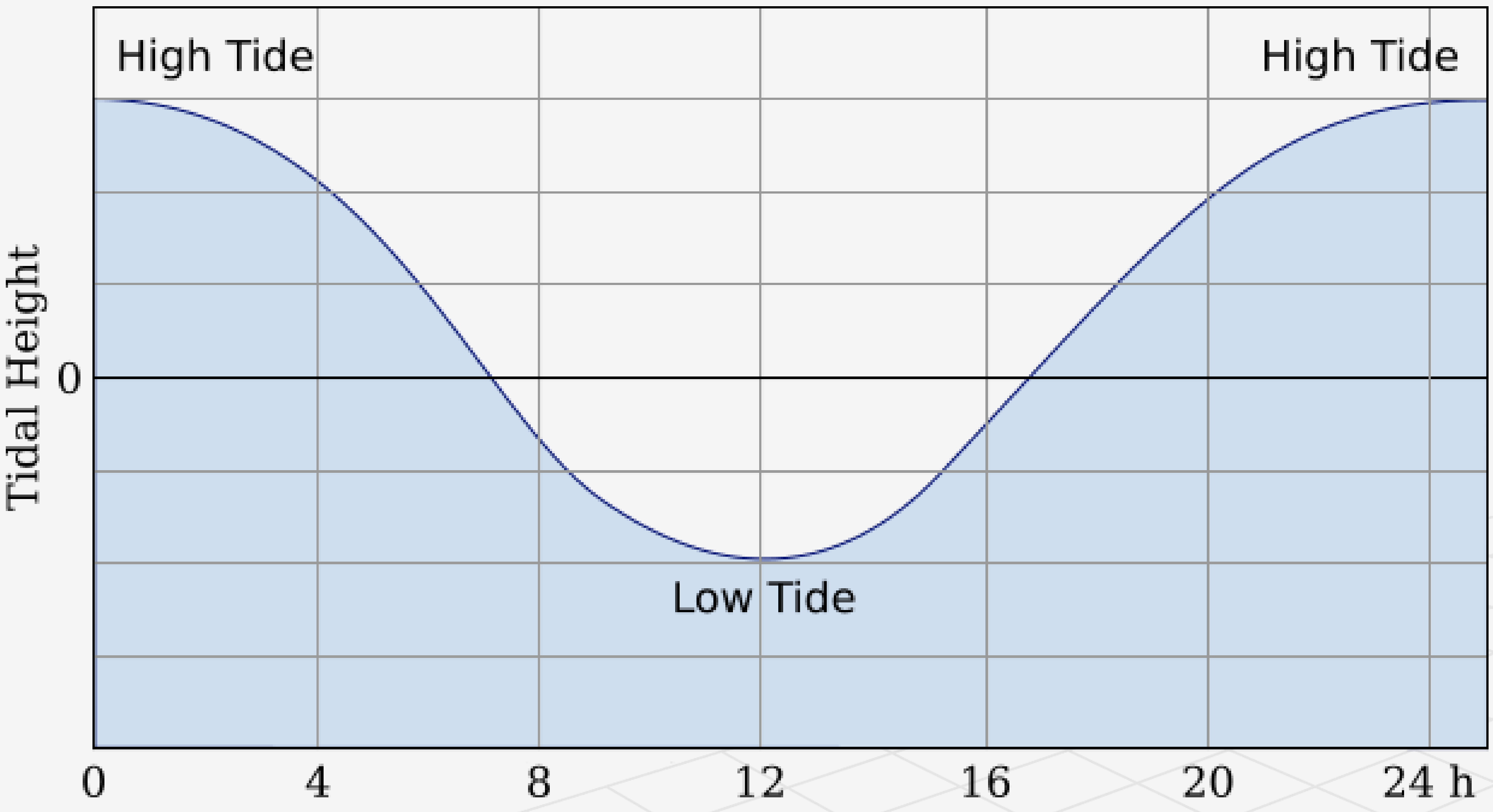
The term diurnal can mean “during the day” (antonym of nocturnal), but with respect to tides it means “Having a daily cycle that is completed every 24 hours”.

The prefix “semi” means “half”.



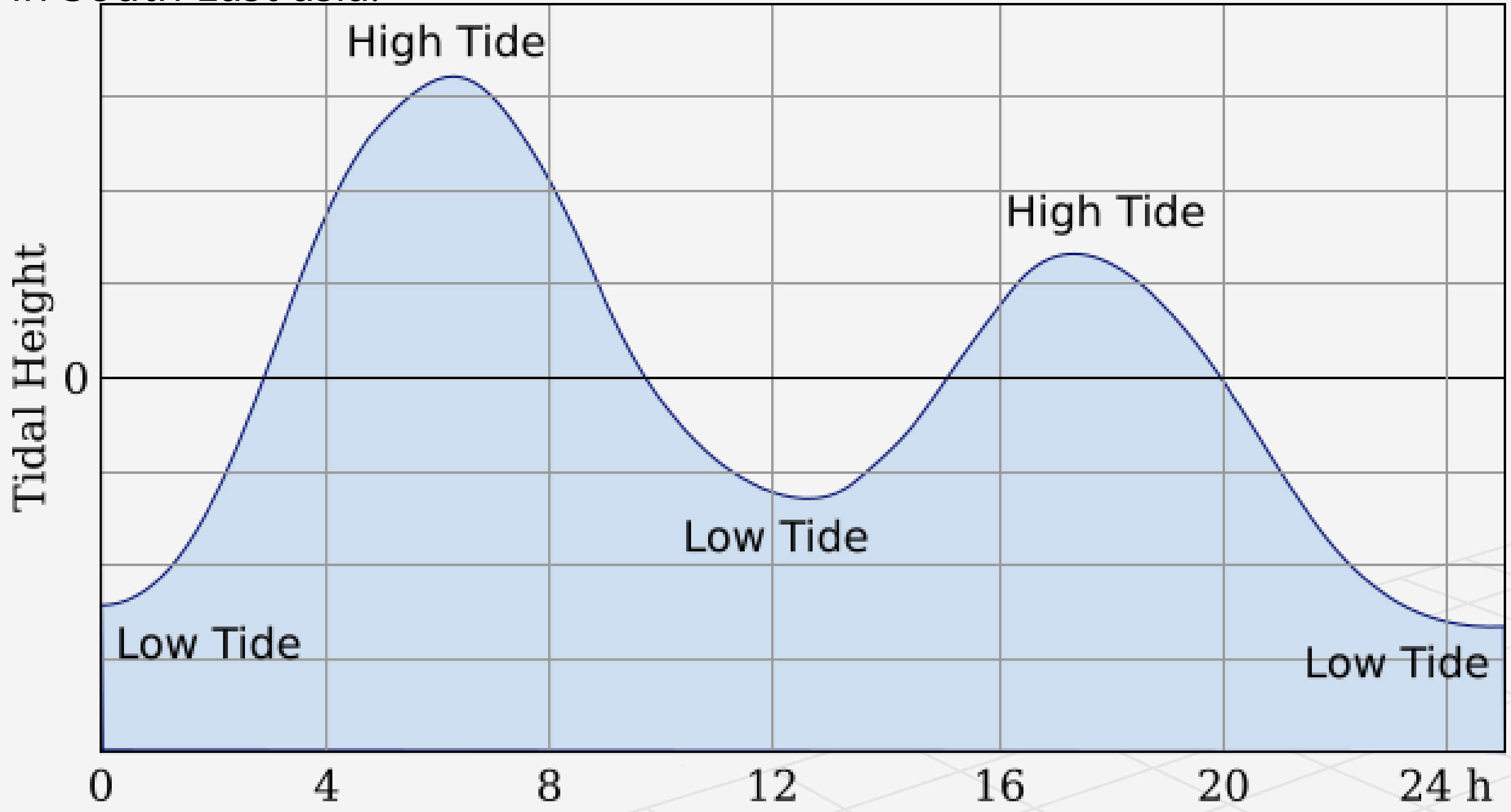
Diurnal tide

A diurnal tidal cycle is a cycle with only one high and low tide each lunar day. The tidal period is 24 hours and 50 minutes and indeed twice as long a the semidiurnal cycle. Diurnal tides can be found in the Gulf of Mexico and on the East coast of the Kamchatka Peninsula.

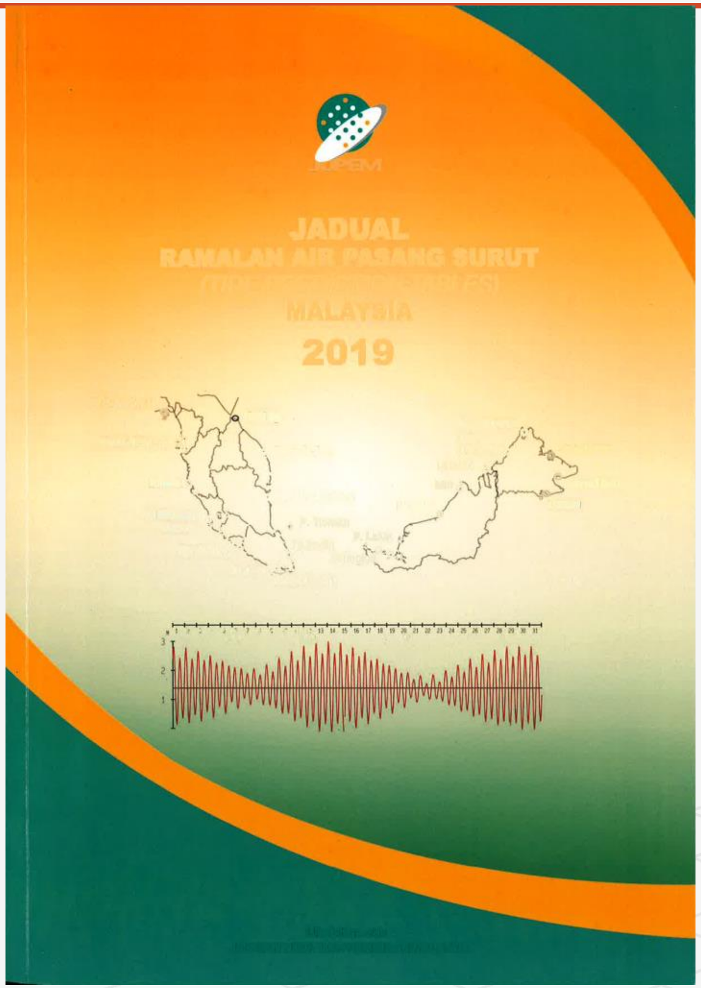


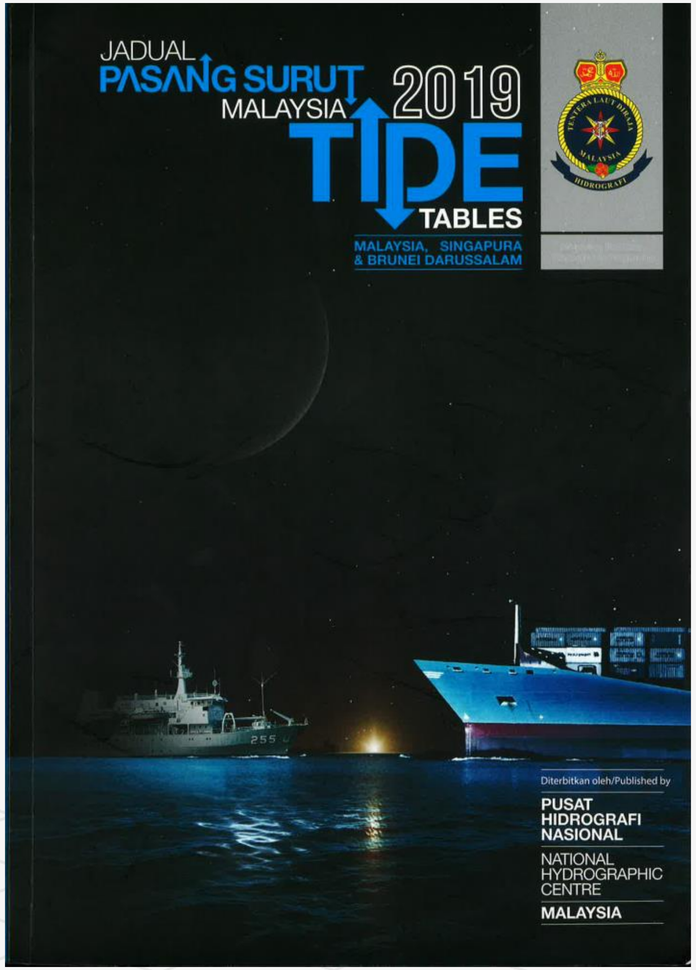
Mixed semidiurnal tide

A mixed semidiurnal tidal cycle is a cycle with two high and low tides with different sizes each lunar day. The difference in height between successive high (or low) tides is called the diurnal inequality. Areas with a mixed semidiurnal tidal cycle can be found alongside the West coast of the USA, the Caribbean in parts of Australia and in South East asia.



TIDE TABLE - JUPEM & NHC





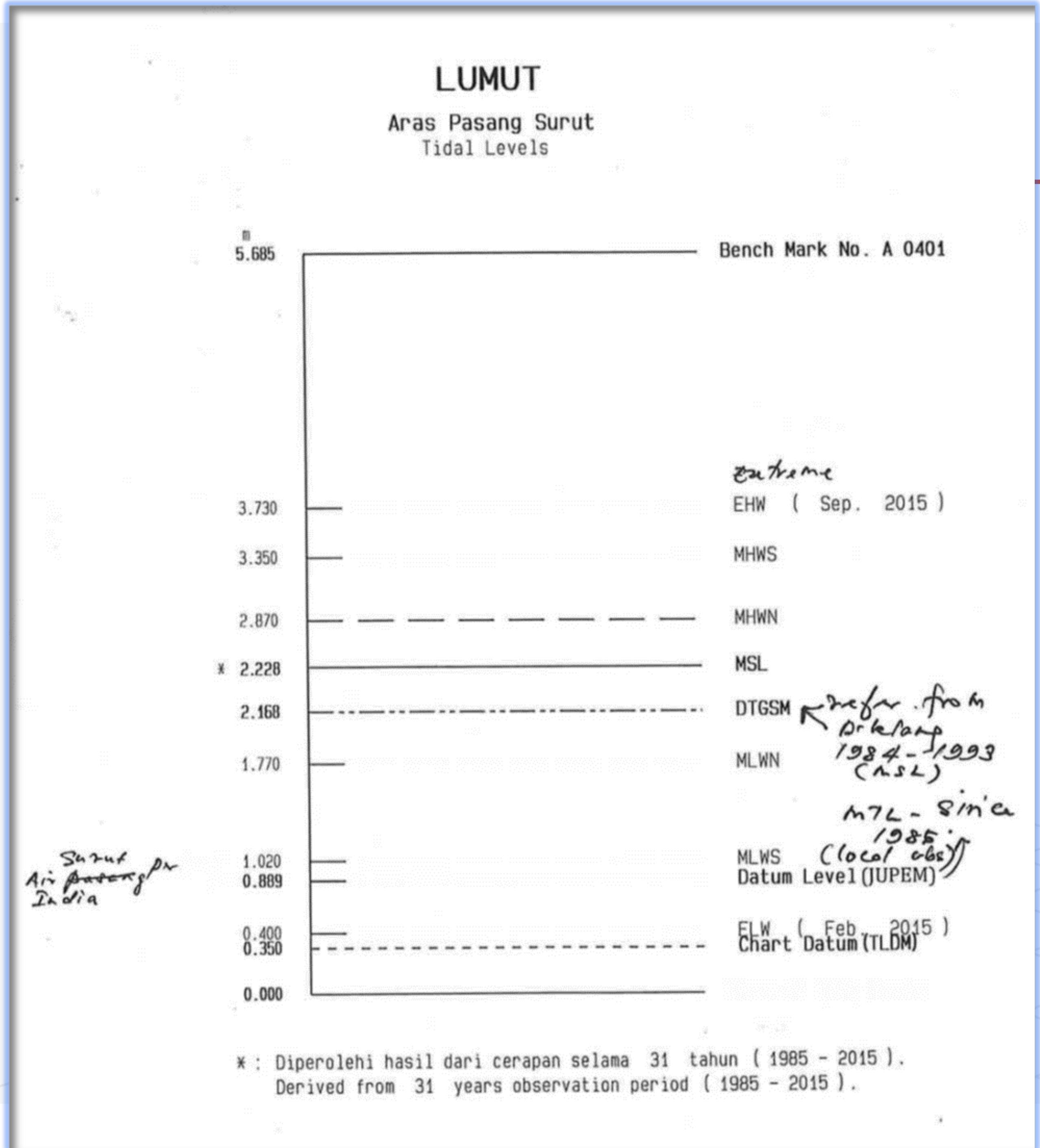
Datum Tegak

Datum Tegak pertama yang digunakan bagi ukuran aras di Semenanjung Malaysia adalah Land Survey Datum 1912 (LSD1912). Datum ini telah ditentukan oleh pihak ‘British Admiralty’ dalam tahun 1912. Ia adalah nilai paras air laut min di Pelabuhan Klang ( ) yang diperolehi daripada nilai-nilai data cerapan Air Pasang Surut selama 365 hari. Semua ketinggian yang diukur selepas tahun tersebut dirujuk kepada datum ini.

Dalam usaha untuk mewujudkan datum baru bagi kerja-kerja kawalan pugak bagi menggantikan datum LSD1912, Jabatan Ukur dan Pemetaan Malaysia telah menjalankan tiga projek iaitu Cerapan Air Pasang Surut, Graviti dan Ukuran Aras Jitu bermula pada tahun 1983.

Cerapan Air Pasang Surut

Projek Cerapan Air Pasang Surut telah mula dilaksanakan oleh Jabatan Ukur dan Pemetaan Malaysia di bawah Rancangan Malaysia Keempat. Objektif utama ialah untuk menentukan nilai-nilai aras laut di beberapa tempat di perairan Malaysia. Seterusnya ia digunakan bersama jaringan ukuran aras jitu bagi menetapkan datum baru yang dikenali sebagai Datum Tegak Geodesi Semenanjung Malaysia (DTGSM) bagi menggantikan Land Survey Datum (LSD) 1912 sebagai rujukan kebangsaan baru untuk sistemketinggian di Semenanjung Malaysia.



PULAU LANGKAWI

1. Kedudukan :
   Garislintang 06° 25' 49" U
   Garisbujur 99° 45' 47" T

2. Aras Datum :
   4.852 meter di bawah Tanda Aras Jabatan Ukur dan Pemetaan Malaysia, K 0172.

3. Datum Carta :
   5.145 meter di bawah Tanda Aras Jabatan Ukur dan Pemetaan Malaysia, K 0172.

4. Jenis Air Pasang : Surut — Semiharian
   Pasang Perbani 2.74 m
   Pasang Anak 1.84 m
   Julat Perbani 2.53 m
   Sela Air Pasang Min 10^{j} 59^{m}

5. Sisihan piawai :
   Masa teramal ± 10.9 min
   Ketinggian teramal ± 10.6 cm

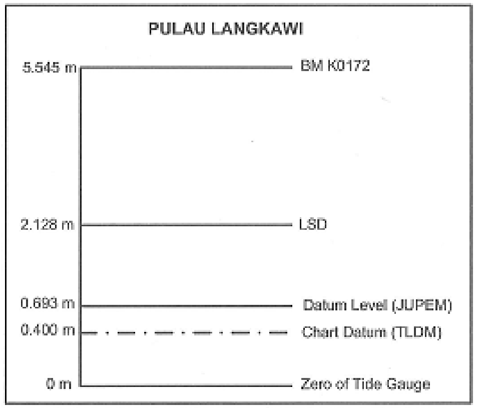
1. Position :
Latitude 06° 25' 49" N
Longitude 99° 45' 47" E

2. Datum Level :
4.852 metres below the Department of Survey and Mapping Malaysia's Bench Mark, K 0172.

3. Chart Datum :
5.145 metres below the Department of Survey and Mapping Malaysia's Bench Mark, K 0172.

4. Type of Tide : Semi-diurnal
Spring Rise 2.74 m
Neap Rise 1.84 m
Spring Range 2.53 m
Mean High Water Interval 10^{h} 59^{m}

5. Standard deviation :
Predicted time ± 10.9 mins
Predicted height ± 10.6 cm



JADUAL AIR PASANG SURUT 2014

Pembinaan STAPS

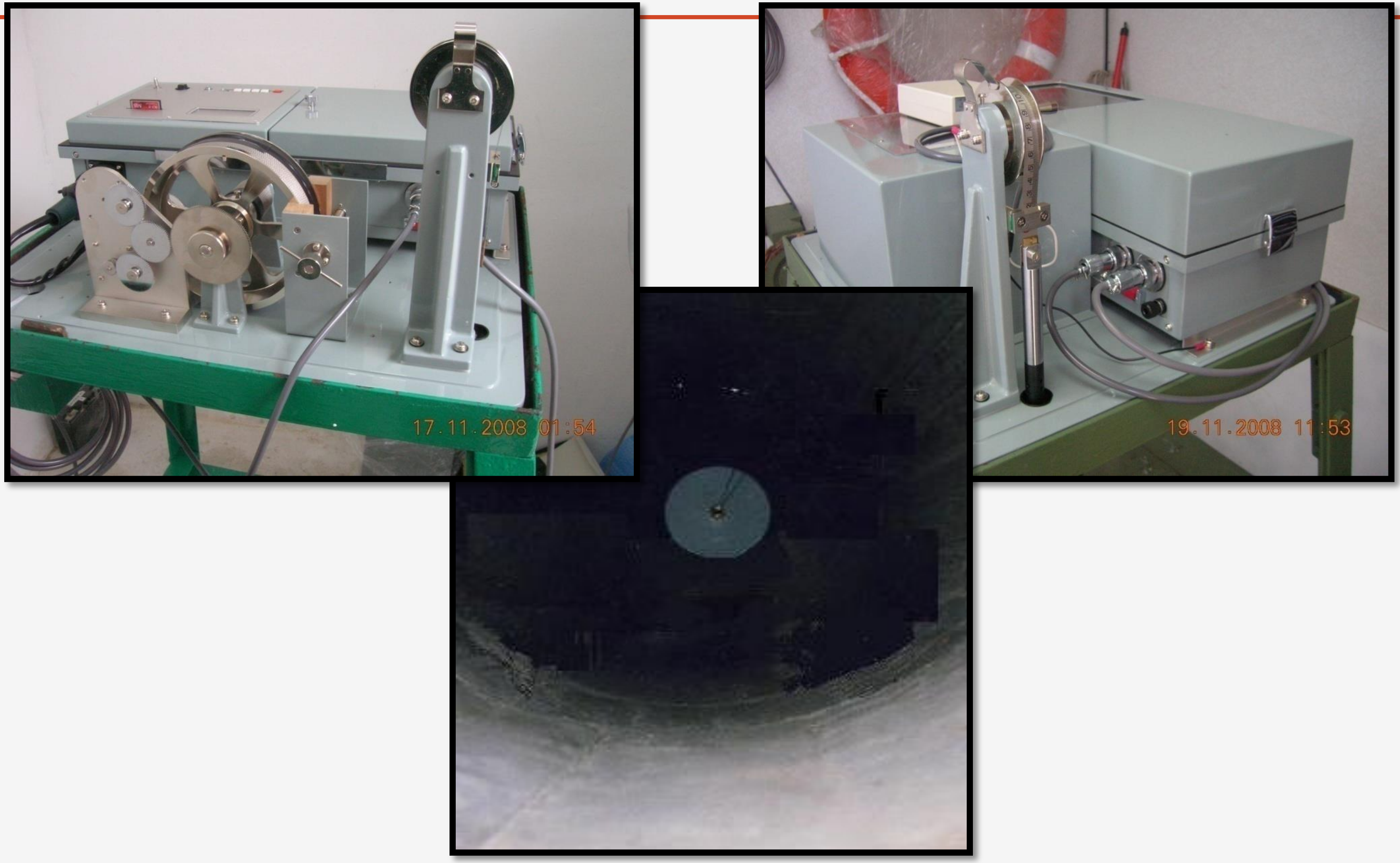
Proses penanaman titik cerucuk (*piling)* semasa pembinaan STAPS Kukup (2005)

Pembinaan STAPS

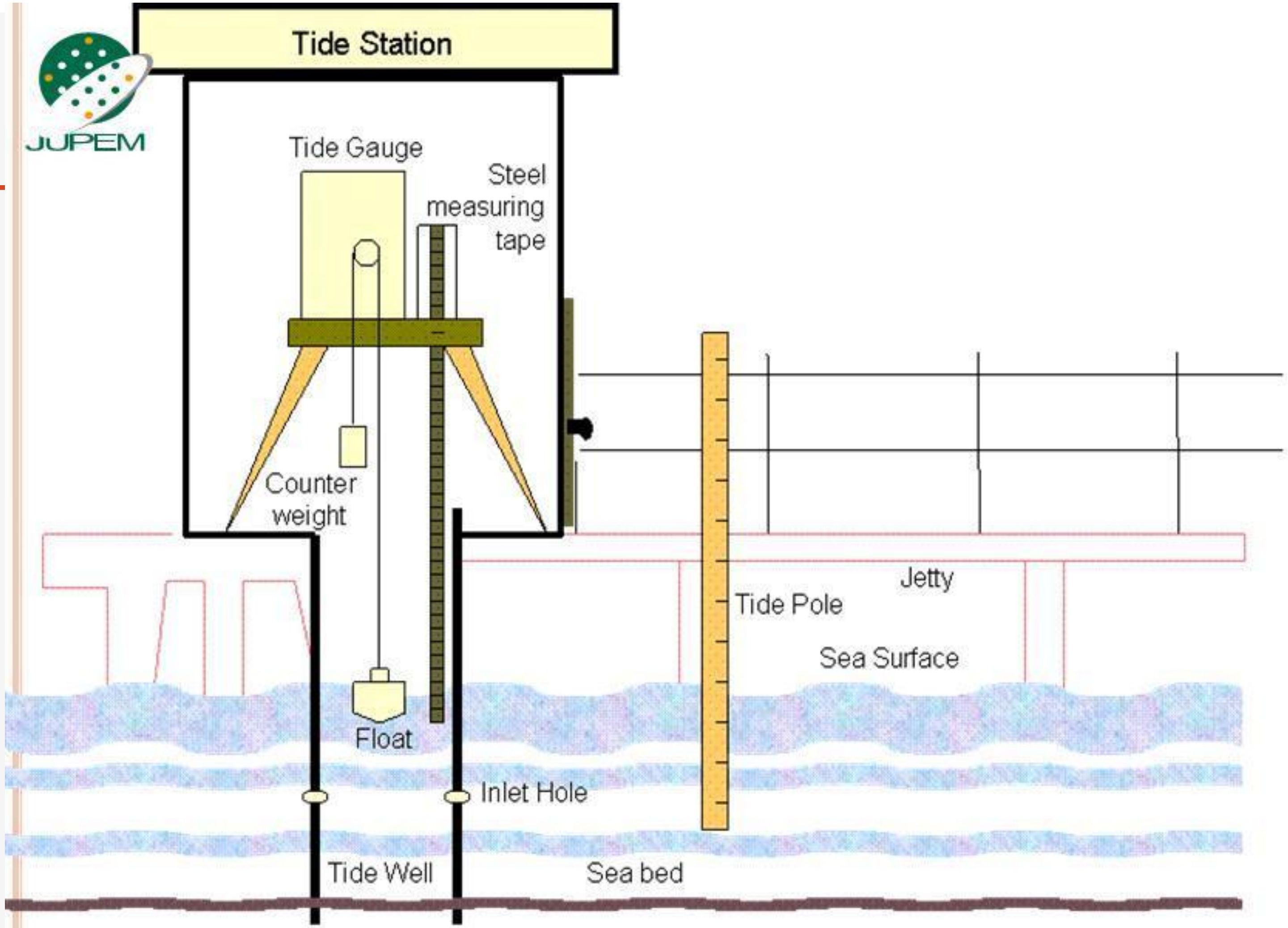
Proses penanaman *Tide Well* semasa pembinaan STAPS Kukup (2005)

JUPEM

Float Type Tide Gauge



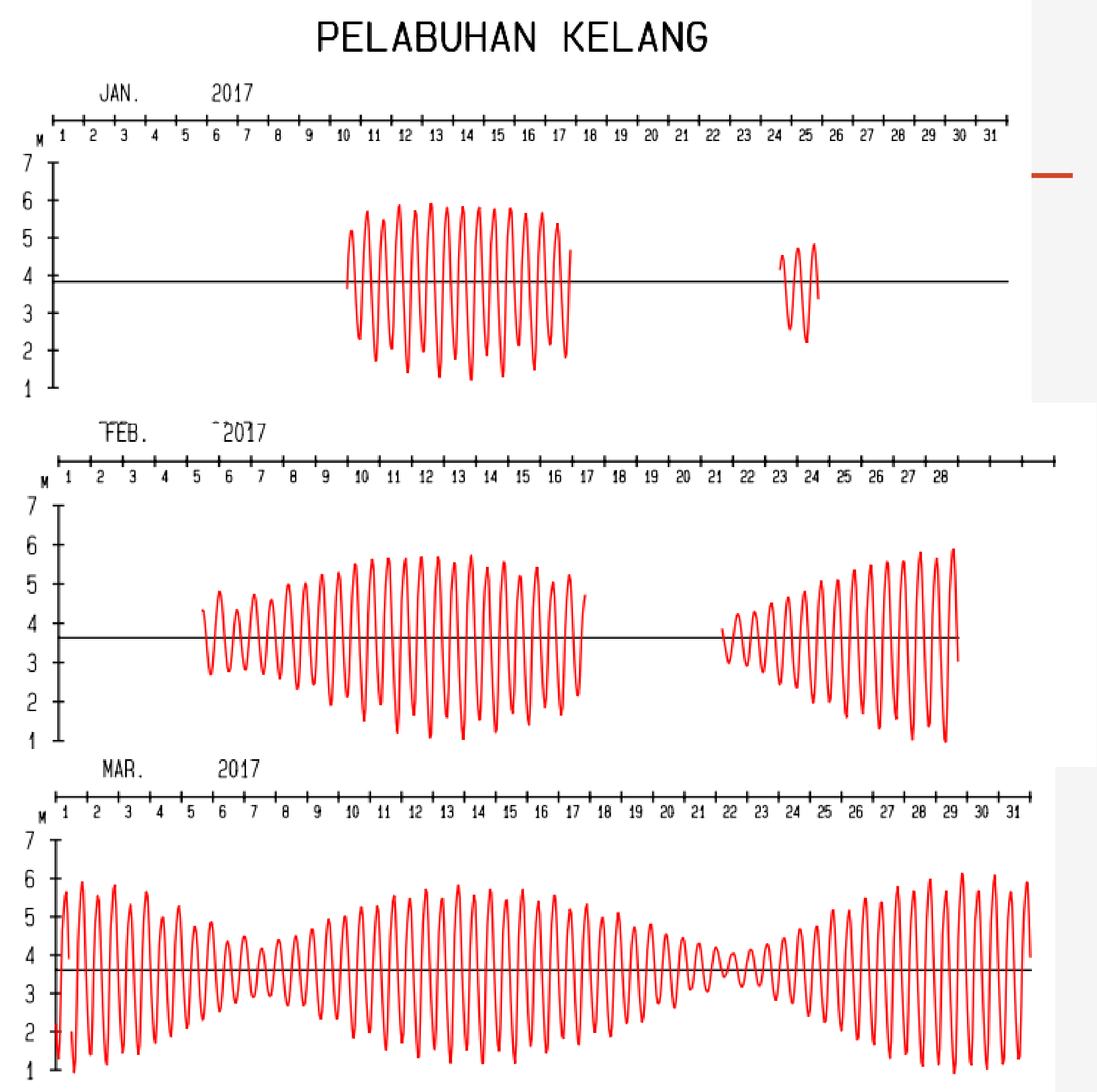
Alat DFT-3 dan *float* di dalam *tide well*



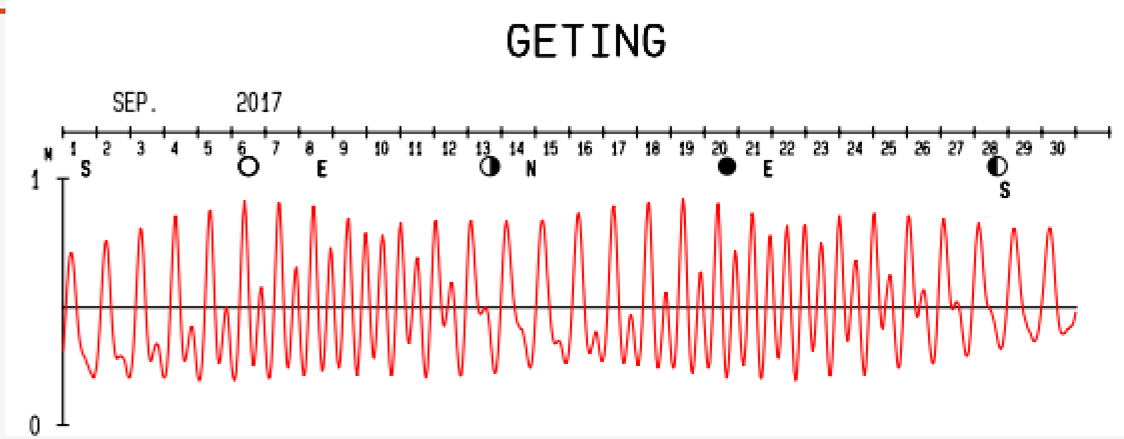
Tide Station
JUPEM
Tide Gauge
Steel
measuring
tape
Counter
weight
Jetty
Tide Pole
Sea Surface
Float
Inlet Hole
Tide Well
Sea bed

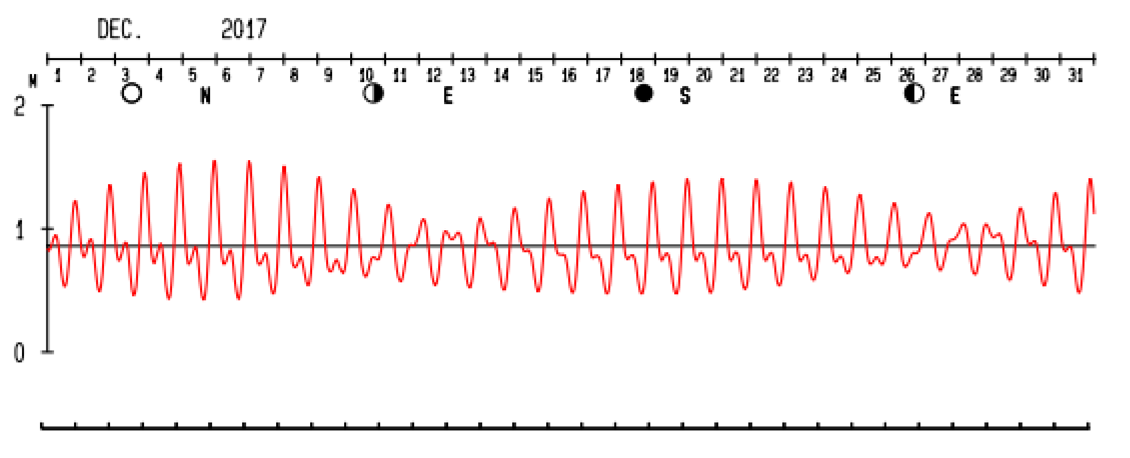
Pressure Levelling Sensor - PLS

Masalah :
1. Gangguan kepada peralatan
2. Bekalan kuasa terputus
3. Kerosakan alatan – barangan gentian sukar/lambat diperolehi



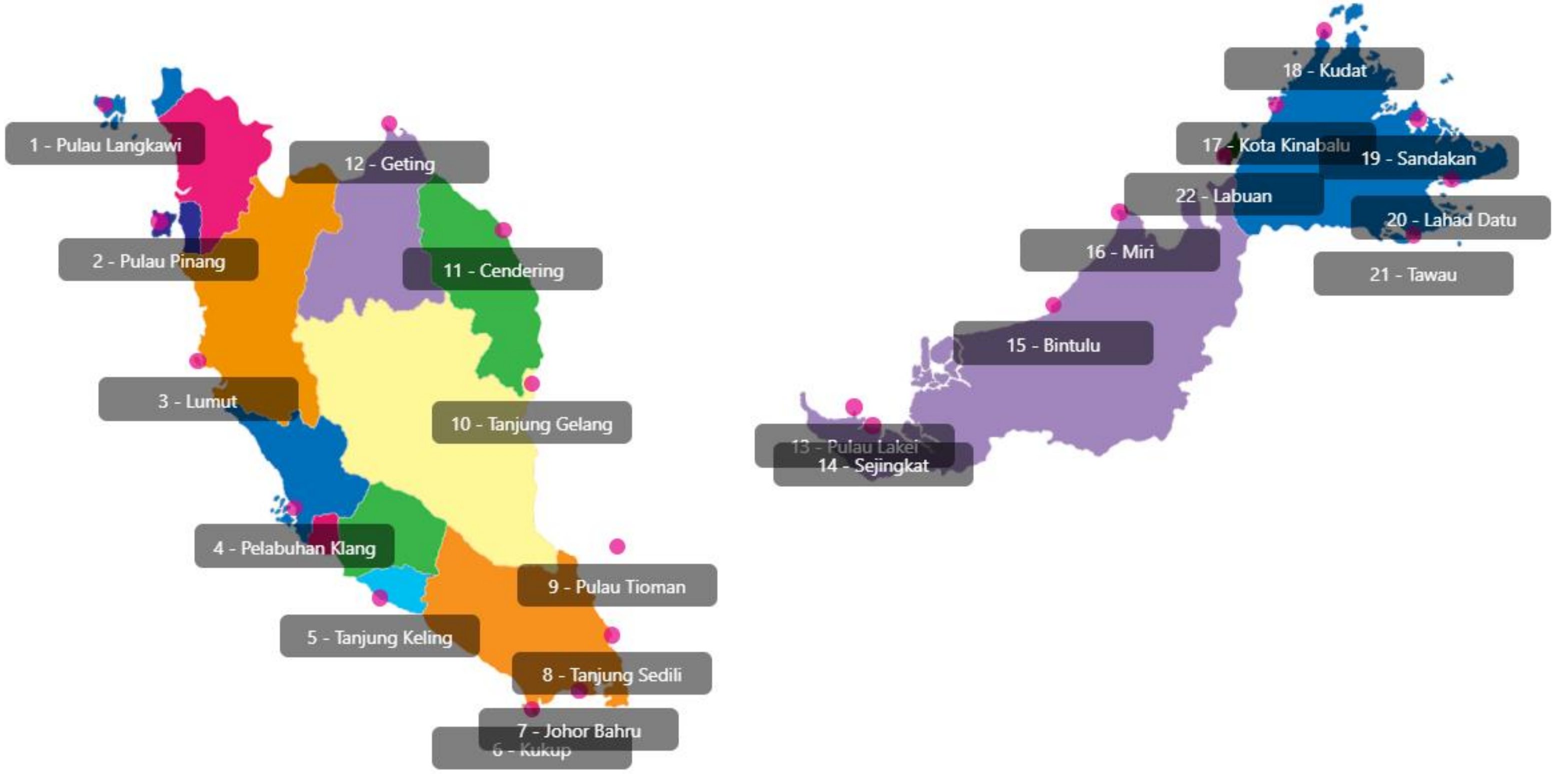
Permasalahan – lokasi yang tidak sesuai





STAPS

Jadual Ramalan Air Pasang Surut Malaysia



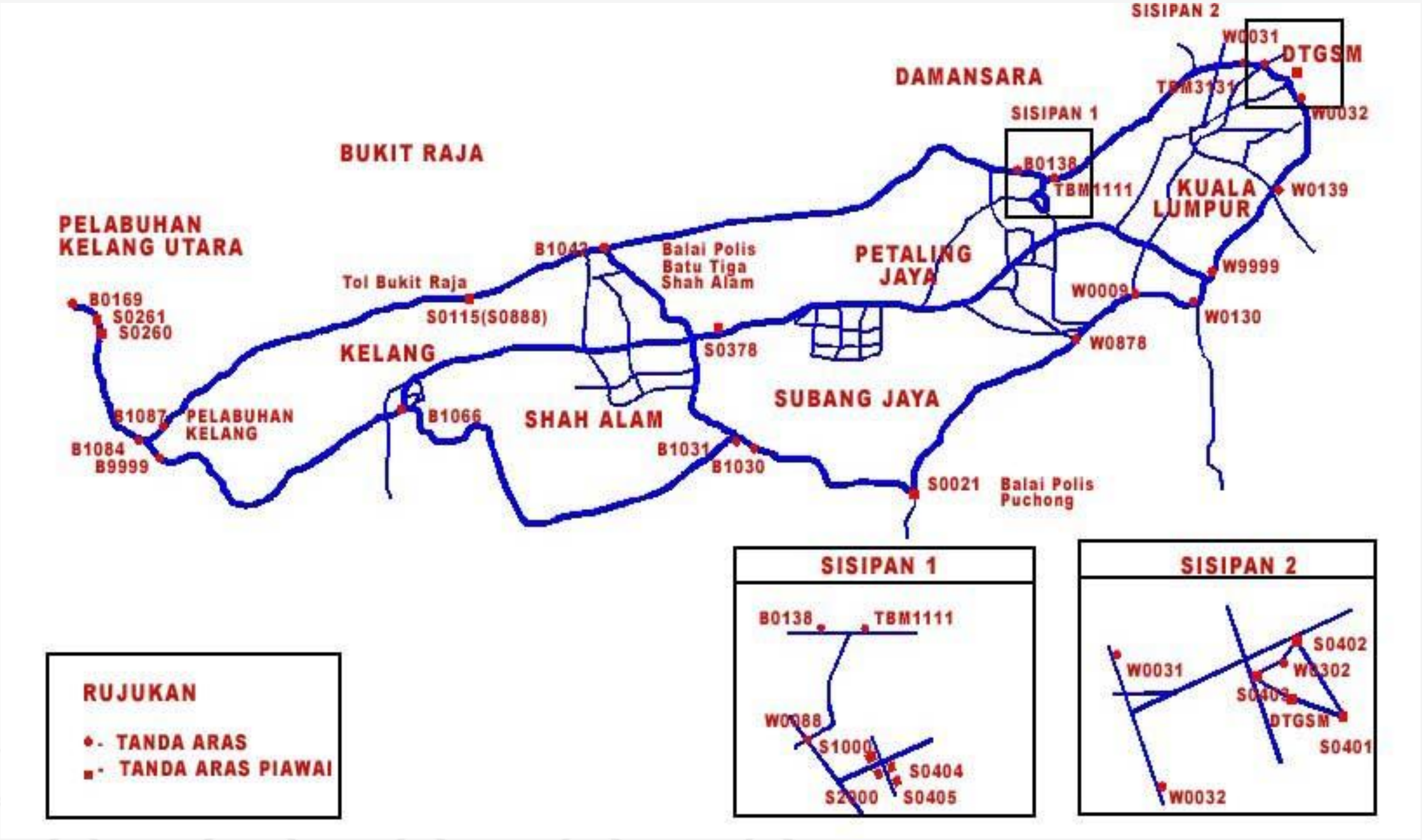
Nota: Sila klik pautan pada ikon ● di stesen untuk melihat maklumat ramalan air pasang surut.

Ukuran Jitu Dilapangan

Terdapat dua jenis tanda aras yang dibina dan digunakan dalam proses pengukuran aras. Jenis-jenis tanda aras:

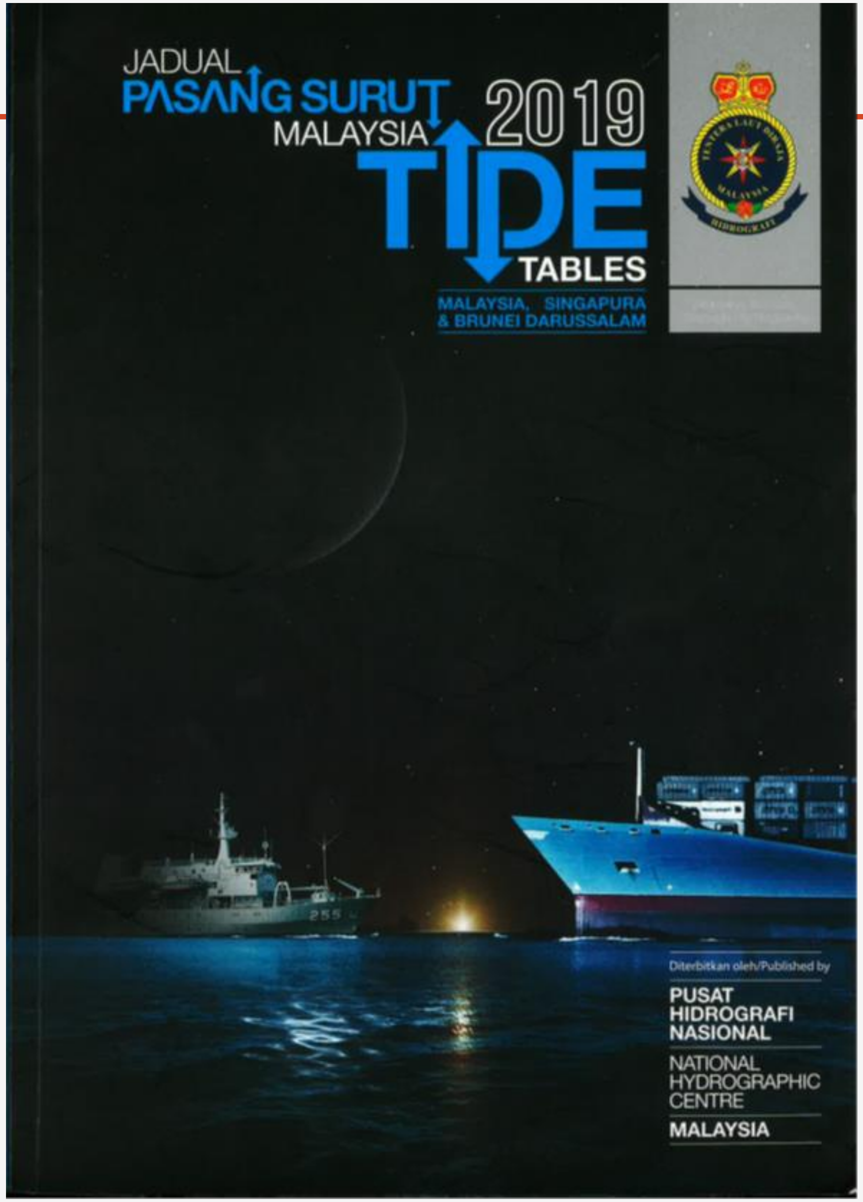
Tanda Aras Piawai (Standard Benchmark-SBM)

Tanda Aras (Benchmark-BM)



Laluan pengukuran Aras dan Ukuran Graviti dari stesen Air Pasang Surut di Port Kelang ke Monumen DTGSM

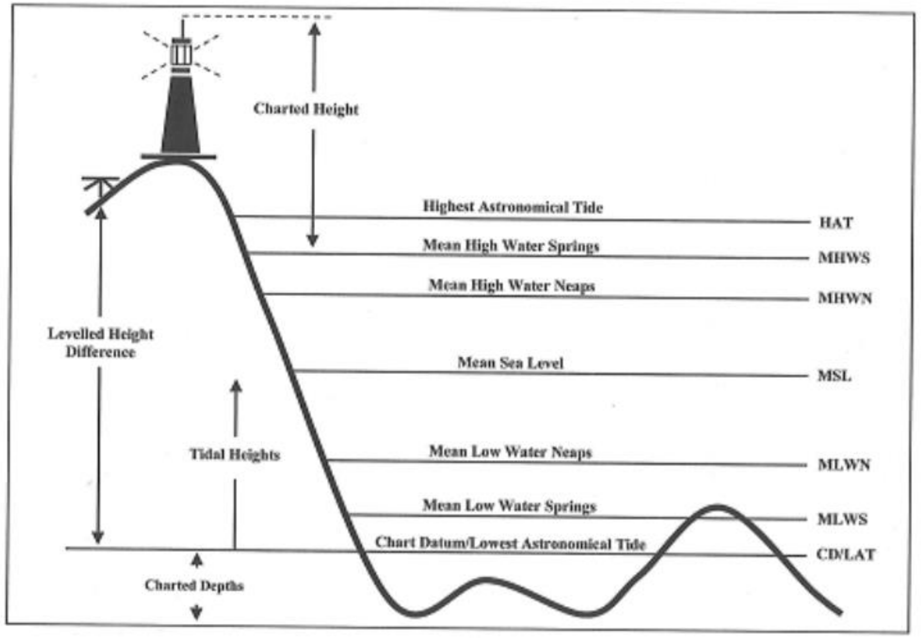

Padang Besar
Bukit Kayu Hitam
Kangar
Naka
Pulau Langkawi
Alor Setar
Gurun
Sik
Geting
Kota Bharu
Baling
Jeli
Pulau Pinang
Butterworth
Gerik
Chendering
Bagan Serai
Gua Musang
Ipoh
Ayer Tawar
Lumut
Sitiawan
Benta
Jerantut
Tg. Gelang
Tranum
Behrang
Sg. Besar
Kuantan
Kg. Awah
K.Kubu
Bentong
Gambang
Karak
Temerloh
K. Lumpur
Muadzam
Pelabohan Kelang
Leban Chondong
Serting
Keratong
Seremban
Pulau Tioman
Pedas
Segamat
Linggi
Ayer Keroh
Melaka
Jemaluang
Tg. Keling
A. Hitam
Sedili
Bt.Pahat
Skudai
Pontian Kecil
Johor Bharu
Kukup
TIDE GAUGE STATION
JUNCTION POINT
LEVELING NETWORK



Tide Table – NHC RMN

LOKASI PELABUHAN-PELABUHAN PIAWAI SEMENANJUNG MALAYSIA DAN SINGAPURA
LOCATION OF STANDARD PORTS PENISULAR MALAYSIA AND SINGAPORE

GLOSARI ISTILAH PASANG SURUT		TIDAL GLOSSARY TERMS
Datum Carta, Datum Untuk Penyurutan Pemeruman	CD	*Chart Datum, Datum For Sounding Reduction*
Air Surut Falak Terendah	LAT	*Lowest Astronomical Tide*
Air Pasang Falak Tertinggi	HAT	*Highest Astronomical Tide*
Aras Laut Min	MSL	*Mean Sea Level*
Air Surut Perbani Min	MLWS	*Mean Low Water Spring*
Air Pasang Perbani Min	MHWS	*Mean High Water Spring*
Air Surut Anak Min	MLWN	*Mean Low Water Neaps*
Air Pasang Anak Min	MHWN	*Mean High Water Neaps*

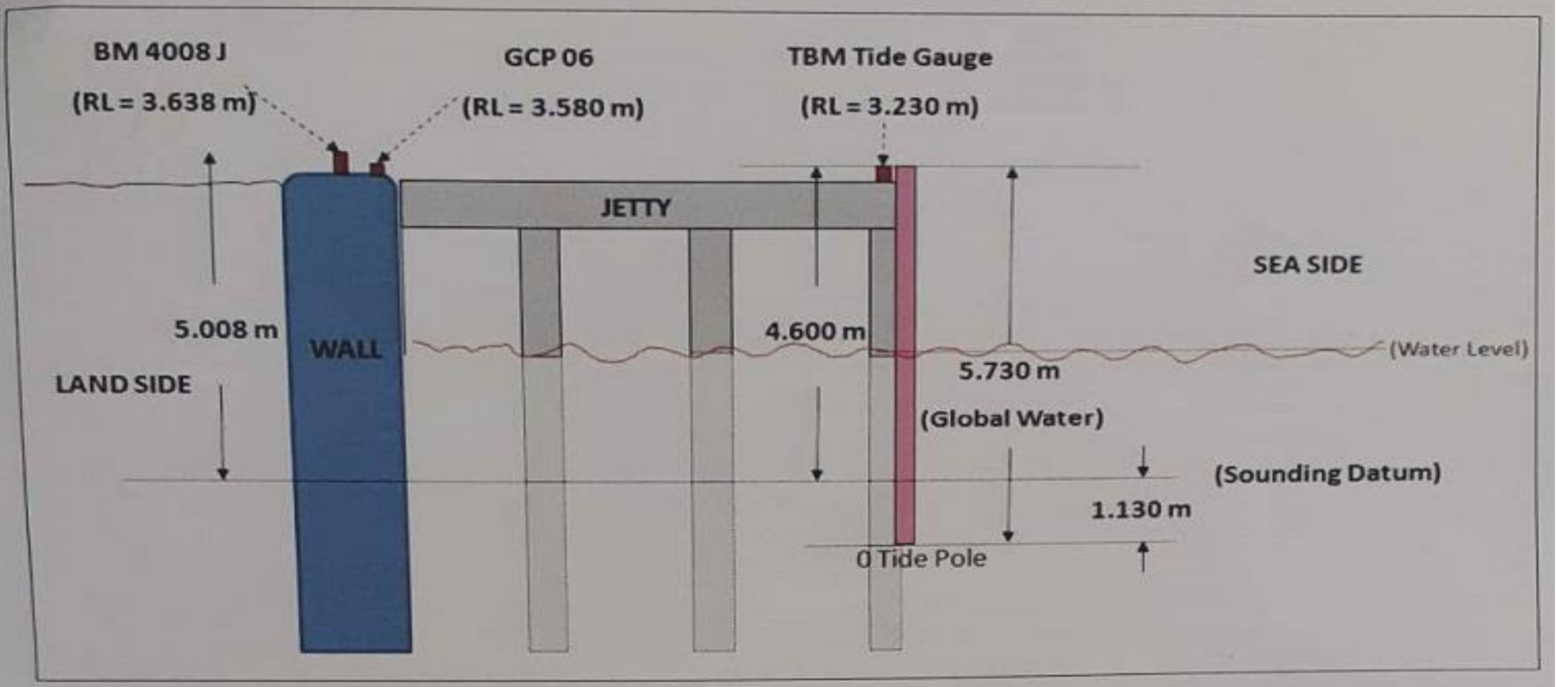


ARAS PASANG SURUT SEPARUH HARIAN PELABUHAN PIAWAI MALAYSIA
SEMI DIURNAL TIDAL LEVELS AT MALAYSIA STANDARD PORT

Pelabuhan Piawai *Standard Port*	Air Surut Falak Terendah *Lowest Astronomical Tide*	Air Surut Perbani Min *Mean Low Water Spring*	Air Surut Anak Min *Mean Low Water Neap*	Aras Laut Min *Mean Sea Level*	Air Pasang Anak Min *Mean High Water Neap*	Air Pasang Perbani Min *Mean High Water Spring*	Air Pasang Falak Tertinggi *Highest Astronomical Tide*	Pihak Berkuasa (a) *Authority for (a)*			Tahun Cerapan (b) *Years of Tidal Observations (b)*
								Cerapan *Observations*	Pemalar *Constants*	Ramalan *Predictions*	
	m.	m.	m.	m.	m.	m.	m.				
Teluk Ewa	0.00	0.56	1.46	1.82	2.18	3.07	3.56	DSM	RMN	RMN	1991 - 04 (13 years)
Kuah	0.00	0.53	1.33	1.64	1.94	2.74	3.26	RMN	RMN	RMN	2005 - 09 (4 years)
Kuala Perlis	0.00	0.56	1.40	1.68	1.96	2.80	3.69	RMN	RMN	RMN	2005 (6 mths)
Kedah Pier, Pulau Pinang	0.00	0.72	1.45	1.71	1.96	2.69	3.09	DSM	RMN	RMN	1989 - 03 (13 years)
Butterworth	0.00	0.77	1.48	1.72	1.96	2.67	3.06	RMN	RMN	RMN	2004 - 06 (2 years)
Kuala Sepetang	0.00	0.82	1.45	1.76	2.06	2.69	2.96	RMN	RMN	RMN	2010 – 11 (1 years)
Lumut	0.00	0.75	1.45	1.85	2.24	2.94	3.45	DSM	RMN	RMN	1989 - 03 (13 years)
Bagan Datoh	0.00	0.52	1.25	1.72	2.20	2.93	3.48	RMN	RMN	RMN	2009 - 11 (2 years)
Pelabuhan Klang	0.00	0.98	2.35	3.03	3.72	5.09	5.82	DSM	RMN	RMN	1992 - 05 (13 years)
Permatang Sedepa	0.00	0.85	2.08	2.71	3.34	4.57	5.31	ITS	ITS	RMN	1979 (1 years)
Port Dickson	0.00	0.31	1.14	1.55	1.96	2.79	3.51	ITS	ITS	RMN	1979 (1 years)
Kuala Linggi	0.00	0.31	0.96	1.29	1.61	2.27	2.91	RMN	RMN	RMN	2007 - 09 (1 years)

Bagan Datoh	0.00	0.52	1.25	1.72	2.20	2.93	3.48	RMN	RMN	RMN
Pelabuhan Klang	0.00	0.98	2.35	3.03	3.72	5.09	5.82	DSM	RMN	RMN
Permatang Sedepa	0.00	0.85	2.08	2.71	3.34	4.57	5.31	ITS	ITS	RMN
Port Dickson	0.00	0.31	1.14	1.55	1.96	2.79	3.51	ITS	ITS	RMN
Kuala Linggi	0.00	0.31	0.96	1.29	1.61	2.27	2.91	RMN	RMN	RMN
Tanjung Keling	0.00	0.29	0.88	1.19	1.51	2.10	2.65	DSM	RMN	RMN
Muar	0.00	0.28	0.83	1.17	1.51	2.06	2.59	RMN	RMN	RMN
Kuala Batu Pahat	0.00	0.43	1.15	1.59	2.03	2.75	3.37	ITS	ITS	RMN
Pulau Pisang	0.00	0.42	1.26	1.77	2.28	3.12	3.79	ITS	ITS	RMN
Kukup	0.00	0.37	1.21	1.70	2.20	3.04	3.68	DSM	RMN	RMN
Tanjung Pelepas	0.00	0.30	1.17	1.66	2.16	3.03	3.75	RMN	RMN	RMN
Johor Bahru	0.00	0.99	1.67	2.20	2.73	3.41	4.00	DSM	RMN	RMN

TBM @ Puteri Harbour Ferry Terminal



Computation:

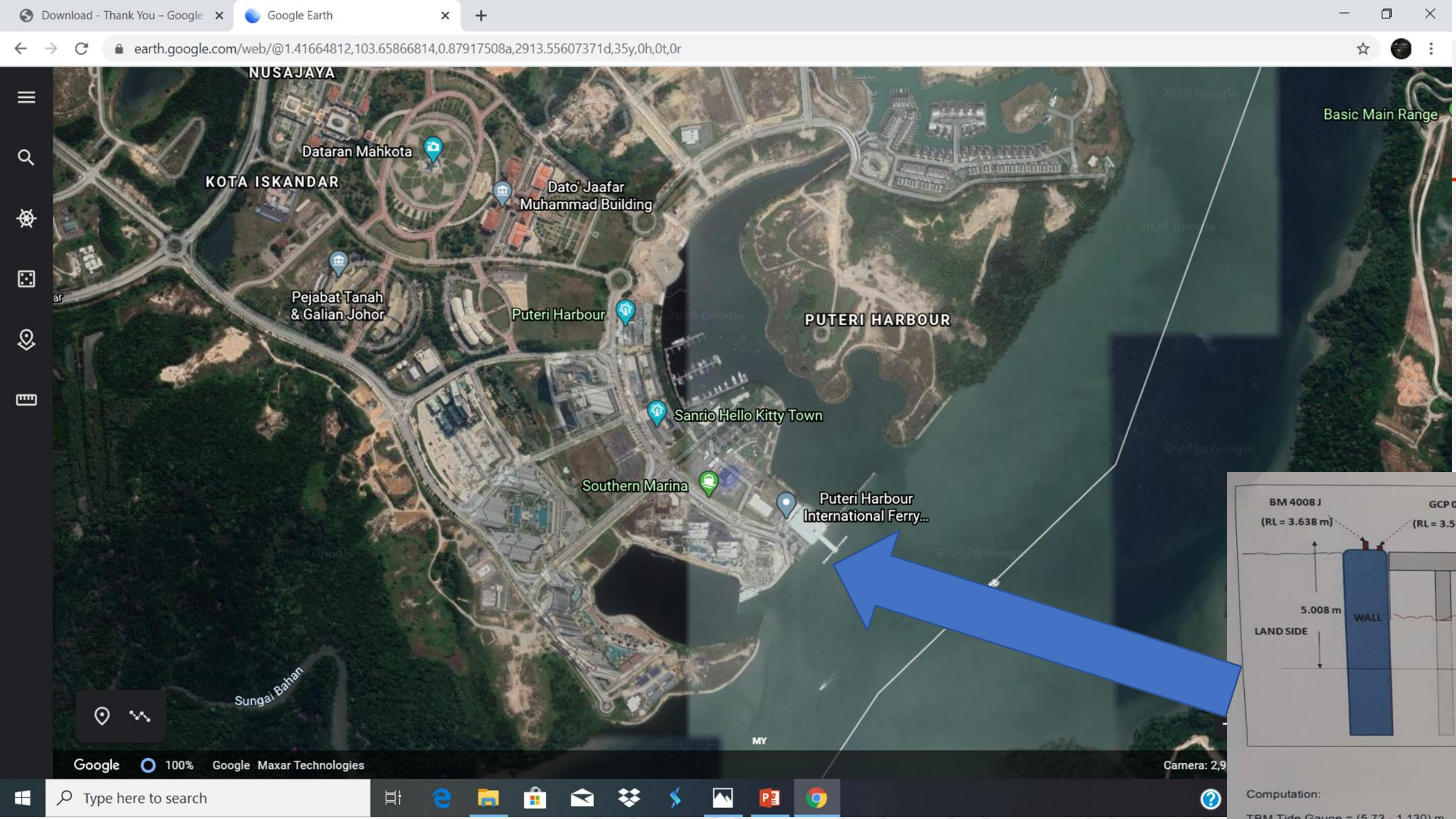
TBM Tide Gauge = (5.73 - 1.130) m
= 4.600 m

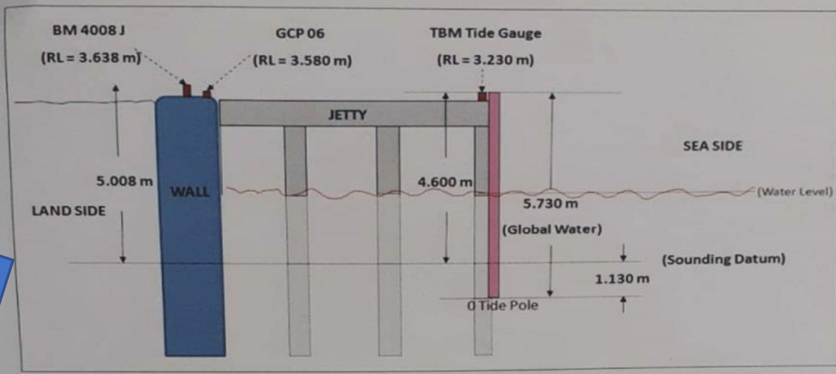
Sounding Datum adopted is 4.600m below TBM Tide Gauge located at the edge of the Jetty Cruise Terminal, Puteri Harbour.

Computation:

BM 4008J = (3.638 - 3.230) + (5.73 - 1.130) m
= 0.408 + 4.600 m
= 5.008 m

Sounding Datum adopted is 5.008 m below BM 4008J located at Jetty Cruise Terminal, Puteri Harbour.





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= 0.408 + 4.600 m
= 5.008 m

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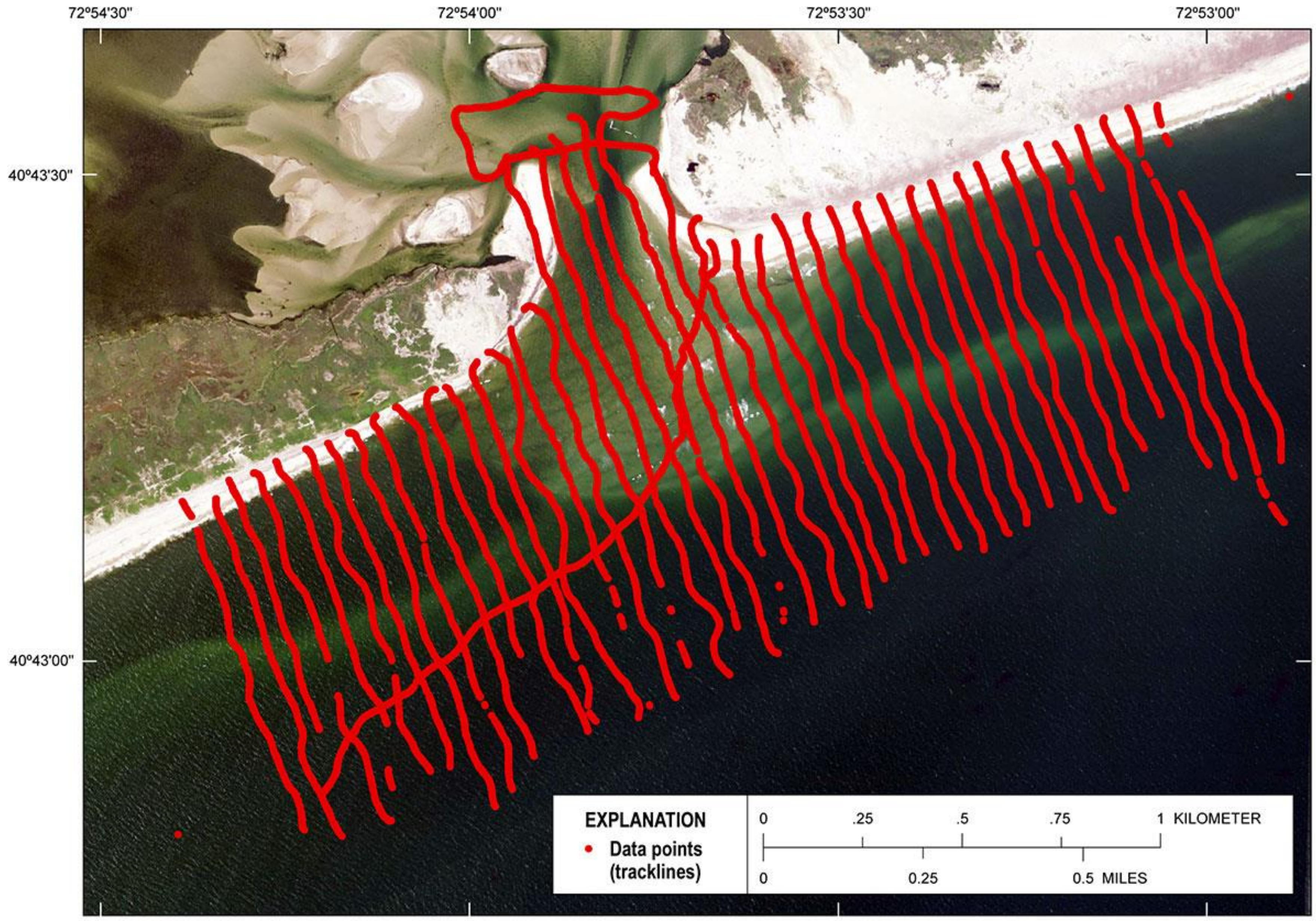


single/dual frequencies - survey

1. Project appointment

Two ways to get a hydrographic survey project through ***open tenders*** or ***direct negotiations***

...dredging?

...construction?

...navigation?

if successful, the appointment letter will be issued

Planning in hydrographic survey work

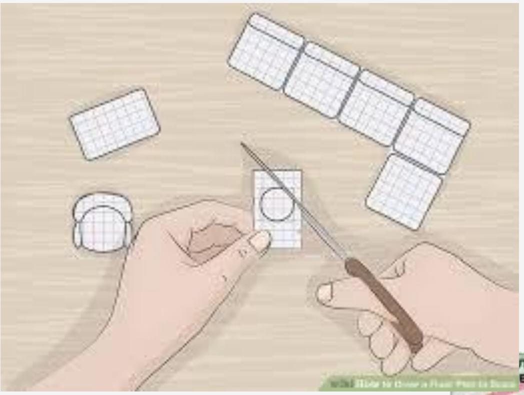
Scope of Work

This Scope of Works for hydrographic survey shall cover a complete process of survey operation from the planning phase to the submission of the result, which are as follows:

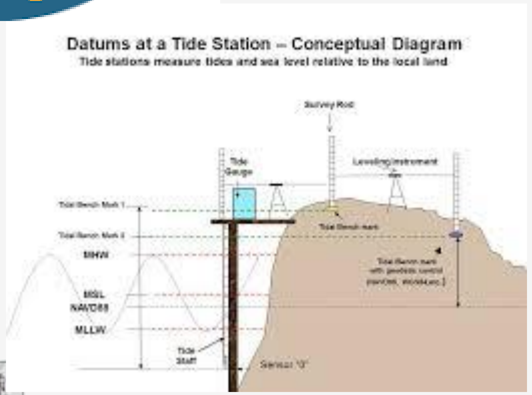
As a start, only the basics need to be known. Among the matters are as follows

- location of work area

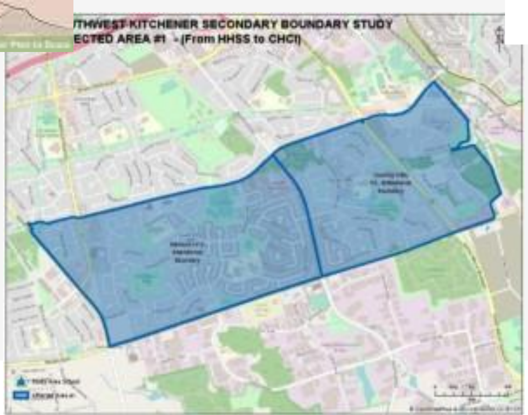
- equipment



- boundaries of work area



- datum information



- the scale of the final plan

2. Review survey area

that information to help the surveyor get a rough idea of the survey to be carried out

The location of the position of the coast control station and the coastline can be determined first

The final plan scale information can help the surveyor determine the interval between the depth lines

2. Review survey area / recce

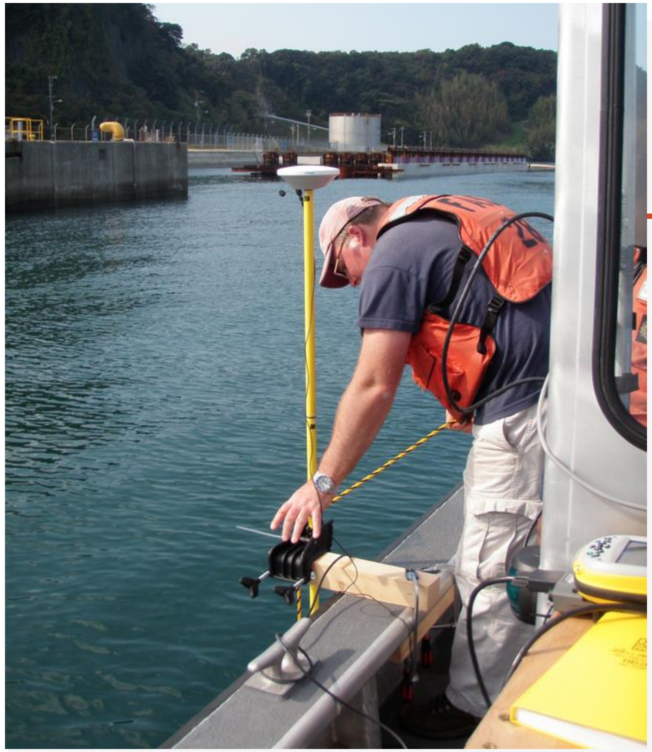
Review is very important and must be carried out carefully for planning purposes

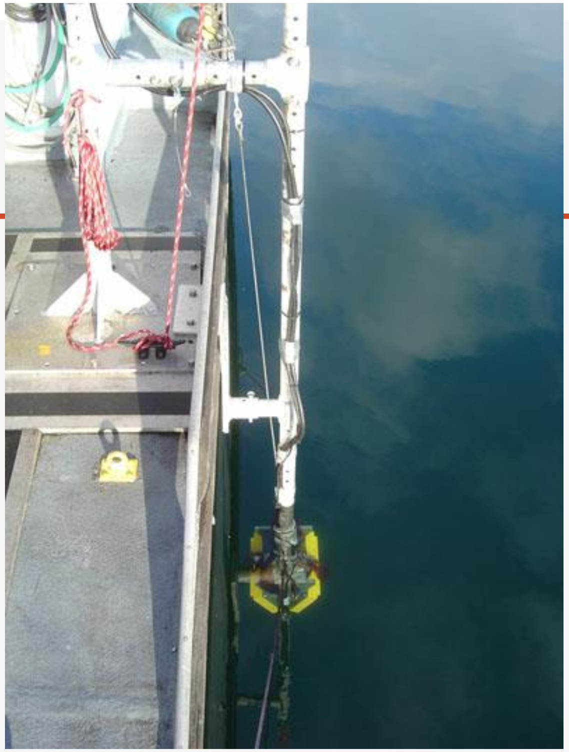
The review aims to study the survey area for information that can help the project run smoothly

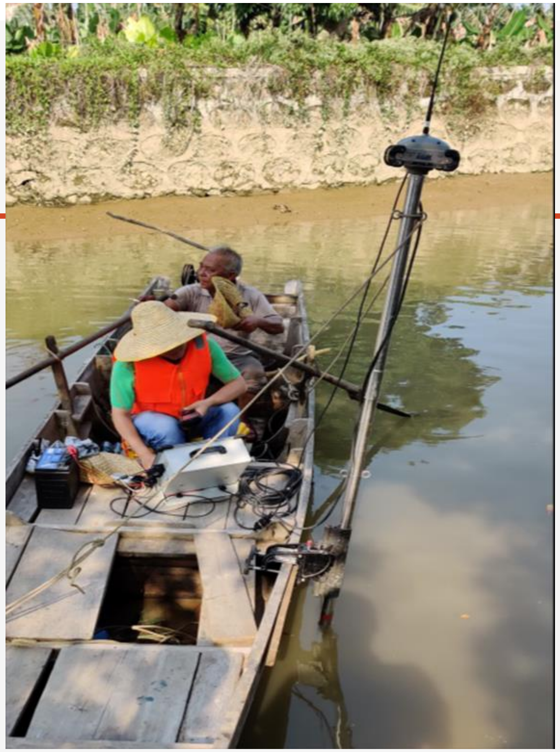
Some of the information needed during the review process is….

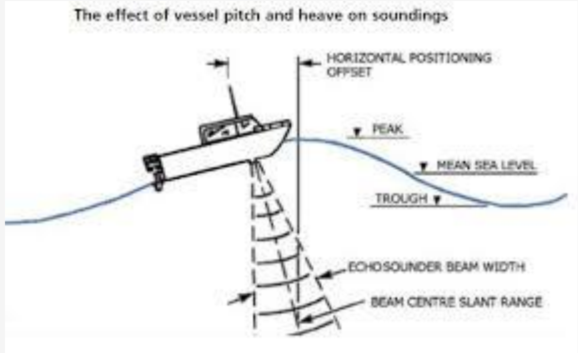
- ✓ boundaries of work area

- ✓ approximate depth of work area
- ✓ the current weather conditions
- ✓ sea traffic conditions
- ✓ terrestrial topography (terrestrial shape, land type, marsh or mangrove)
- ✓ location of the control station
- ✓ the location of the gauge station
- ✓ Type of boat & rental rates
- ✓ selection of land positioning and depth acquistion equipment








The effect of vessel pitch and heave on soundings
HORIZONTAL POSITIONING OFFSET
PEAK
MEAN SEA LEVEL
TROUGH
ECHOSOUNDER BEAM WIDTH
BEAM CENTRE SLANT RANGE

- ✓ reviewing and purchasing related plans at JUPEM to begin benchmarking and get information on adjustable height and height from JUPEM and PHN
- ✓ provides support equipment such as safety jackets, pickets, wood, nails, stationery, paints and stationery, torchlight, measuring tape, masking tape. etc

information on the sheet/charting paper

- shoreline - land and water boundaries. Usually the highest of water line is referred to
- coastline - land and water boundaries. Usually the highest level of water is referred to
- depth and dry height - the height of the shoreline and dry area refer to the chart datum
- depth contour - lines with the same depth
- submarine quality - a name that describes the type of sea floor such as rock, mud, sand

- Cruise assistance - featuring dangerous areas (reefs, shipwrecks), lifts, safety buoys, safe passage
- landmarks are natural or artificial signs that are visible from the beach and can be used for distance and baering such as buildings, hills, towers cimny
- Maritime details – man made structure is very important or useful items for navigation such as jetty, harbor, bridge
- coastal and inland topography - natural or man-made details, contour lines, heights

How to do a bathymetric survey?

1. Mobilise all equipment

Mobilisation of all equipment can include transporting the survey boat and launching it in the survey area. In some cases, this is only transport of equipment which can then be deployed on a local hire boat as that can be more cost efficient.

2. Equipment checks and calibration
This is important to make sure equipment is in prime condition when arriving on site.

3. Deployment and equipment setup
This includes the setting up of a bespoke frame which is used to attach all the equipment securely to the boat. This keeps it firmly in place when the boat is moving to ensure high quality data. The transducer is attached to the underwater section of this frame and the GNSS (GPS) antennas are attached at the top of the frame to have as good a view of the sky as possible. The “control hardware” – the echosounder and the GNSS controllers are then connected via marine cables to all other equipment and also to the control computer. The software is then set up with details about the specific survey noted in the survey logs.

4. Sound casting
Measurement of the speed of sound at a specific site to calibrate the transducer. This is because the speed varies with salinity and temperature which can significantly influence the reading of depth.

5. Start the survey
This involves driving the boat whilst logging the depth data over the entire area to be surveyed. This is done by following predetermined survey lines. These lines will be very close together in shallow waters and where the accuracy required is high.

6. Check the data before demobilisation
This is a quick look over all data collected to see whether there are any obvious areas which need more data collection.

7. Demobilise
Power down all equipment, disconnect and wash with fresh water.

8. Process the data
The data must be processed using specialised software with a powerful workstation computer. The hydrographer checks the raw data for any false signals such as returns from floating objects or bubbles in the water. Any inaccurate data is removed and the final map is produced.

Hydrographic Survey Report

1. ***Engagement with Local Authorities***
The contractor/Licenced Land Surveyor/ Hydrographers shall to contact and ***inform relevant national and local authorities*** e.g. Marine Department, Ports Department, Fisheries Department and Royal Navy well in advance of any intended survey work ashore and afloat prior to commencing the work from Marine Department. Marine Department shall produce „Notice To Mariners" regarding the scope of work and location of the survey area.

This Scope of Works for hydrographic survey shall cover a complete process of survey operation from the planning phase to the submission of the result, which are as follows:

- ❖ Determine the Survey Area;
- ❖ Define the scope and specification for the hydrographic survey;
- ❖ Provide details of survey planning including equipment used, survey platform and methodologies for data acquisition and processing used in the hydrographic survey
- ❖ Determine the conduct of the hydrographic survey, commencement date, survey lines and others
- ❖ Agree on the terms and conditions for data format, sharing and exchange
- ❖ Provide competency of person (s) responsible for the surveys

3. Planning

It is the responsibility of the Licensed Land Surveyor/ Hydrographers to provide appropriate hydrographic books/logs and records for use throughout the survey to ensure an audit trail exists for all data collected. Daily or regular back-up of data and storage shall be carried out at the survey platform.

4.2 SOUNDINGS

4.2.1 A plan of operations shall be prepared before commencing to sound. The plan shall provide for the delineation of topography of the seabed in the most economical and expedient manner

4.2.2 The line of sounding shall be run 5mm apart on the sheet, for example, on scale of 1 : 12500, lines are run 62.5 metres apart on the ground

Scale of Survey	Standard Line Spacing
1 : 5 000	25m
1 : 10 000	50m
1 : 25 000	125m
1 : 50 000	250m
1 : 100 000	500m

4.2.3 Cross-lines are to be run at angles of 60 deg or 90deg to the main track-lines. A statistical comparison of raw data between the main survey track and the cross-line is to be undertaken to ensure that the accuracy requirements of the order of the survey are met.

4.2.4 For multibeam echosounder shall perform sounding at slower speeds and greater swath overlaps than for standard survey line.

5. *Survey Limits*

5.1 The survey limits shall extend to at least 25 metre beyond the perimeter of the required working limit or up to the adjacent sea-wall, wharf, coastline, etc.

5.2 Hydrographic survey must cover up to High Water Mark (Line) which is the Mean High High Water (MHHW) mark or Coastline where applicable. Low Water Mark or drying lines shall be shown in details symbolised in accordance with "Hydrographic Plan drafting Specification".

6. *Method and Execution of Survey*

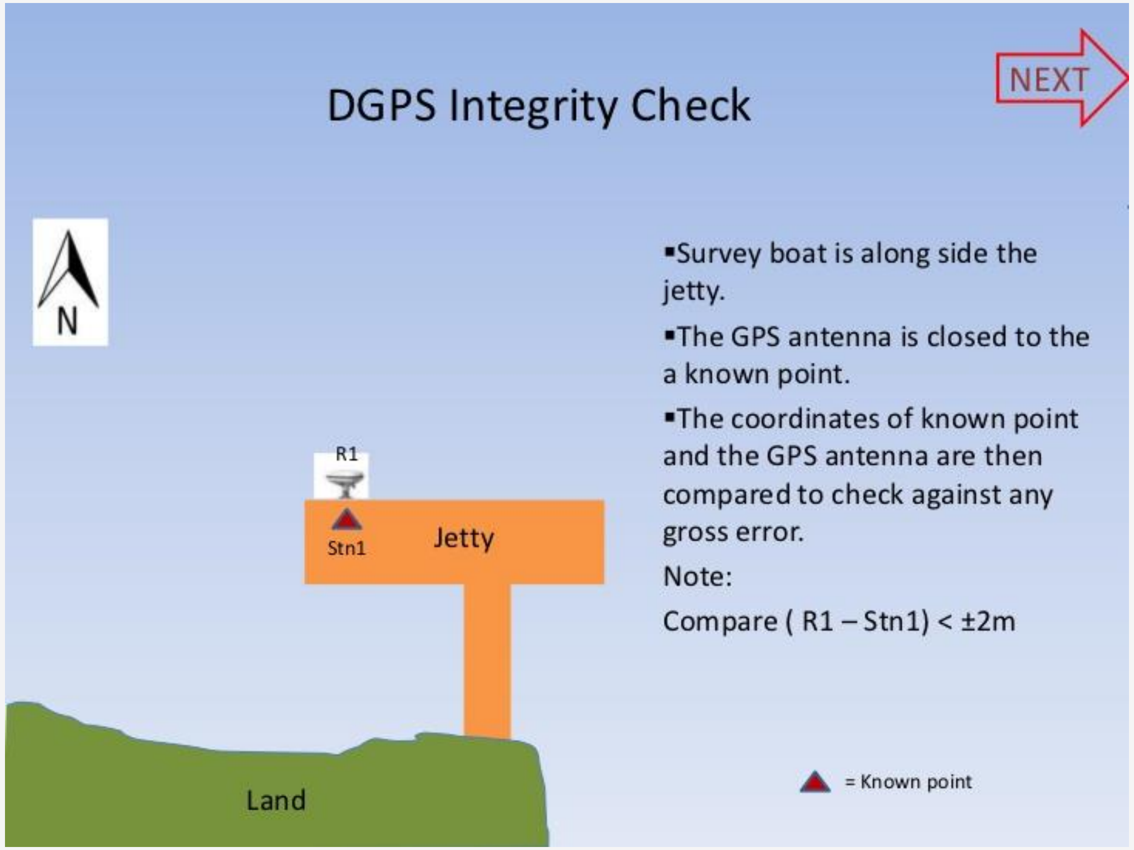
The method and execution of survey shall conform to accepted standards of good survey practice. Where maximum standards of accuracy have to be achieved, these will be laid down in the Schedule to the Specification. Periodical system checks and monitoring shall be conducted to ensure validity of the data.

7. Survey Equipment and Accuracy

7.1 Calibration: Survey equipment that are to be used shall be properly calibrated before they are used in any survey. Calibration records shall maintain and submitted to Surveyor General or his representative for inspection.

7.3 Horizontal Positioning System

The horizontal positioning is to be controlled by Differential Global Positioning System (DGPS) or electronic positioning system such as Total Station providing an accuracy of +/- 1m or better. The DGPS shall be checked against a known coordinated position before and after survey each day. DGPS Integrity shall preform daily to detect any degradation of the accuracy/performance.



Datum

Field Survey Records

The field records shall be maintained for inspection at any time. The care and attention devoted to work in the field must be extended to all aspects of preparing the fair data, and to the careful and legible annotation of all original material. The following records must be duly certified and submitted :-

- 8.1 Name of Surveyor;
- 8.2 Digital or hard copy of daily echo trace and bar-check records, date and time, fix numbers shall be annotated;
- 8.3 All Bathymetric and position data recorded digitally in real time. The raw data comprising date, time, x,y,z coordinates shall be presented in ASCII format;
- 8.4 Digital record in ASCII format of daily tidal height measurement if applicable
- 8.5 Hard copy record of field equipment calibration;
- 8.6 Digital and hard copy plots of the actual tracks travelled by the survey boat;
- 8.7 Digital and hard copy of sounding plots; and,
- 8.8 Any other relevant records is required by from time to time.

9. Hydrographic Plan Drafting Specification (Fairsheet or Plan)

Depth and position data collected in the field shall be transfered to a computer for data processing and plan plotting. Hydrographic processing software shall be used for the purpose.

9.1 The Survey Plan / Fair Sheets will be drawn at scale of 1:1000 or any suitable scale agreed by client for general bathymetric information of surrounding waters in Universal Transverse Mercator Zone 50 projection and WGS84 ellipsoid.

9.2 The plotting scale shall be at the scale that is normally used by Survey Department (1:500, 1:1000, 1:1250, 1:2500, 1:5000 and 1:10000)

9.3 Soundings shall be plotted at intervals of not more than 10 -15mm on plan along the entire sounding line.

9.4 Main sounding lines shall be plotted at intervals of not more than 5 mm on plan at survey scale.

9.5 All symbols, abbreviations and terms depicted on the plan shall be in accordance with the "Survey plan drafting instruction". Depths shown on plans shall be clear, legible and free from over plotting. Any heights of isolated features shall be shown.

9.6 Where cross-sectional plans are to be drawn, the vertical and horizontal scales will be determined by requirements of the client or consultant.

9.7 Results of seabed sampling for post dredging survey shall be plotted on a separate plan at the same survey scale.

9.8 Depth Contour

Standard drying lines and depth contour will be set-out in the “Schedule to the Specification” and shall be drawn on all relevant survey plans. The contours depicting the approved dredging/or dumping depth shall also be drawn on the relevant survey plans where applicable.

9.9 Survey Grid

The survey results shall be plotted in Geocentric Coordinate grid. The grid will be shown by crosses at 100m intervals in Northings and Eastings. Full grid values will be given alongside the grids outside neat line.

10. Submission

10.1 Certification

All plans, field records, reports, data sheet, equipment calibration records, sounding plots, etc shall be certified by surveyors before submitting them to the Surveyor general.

10.2 Survey Plans

The surveyors in charge shall submit:

10.2.1. One transparent polyester base, in black and white

10.2.2. Two paper prints of the survey plans, not larger than AO size,

to the Surveyor General.

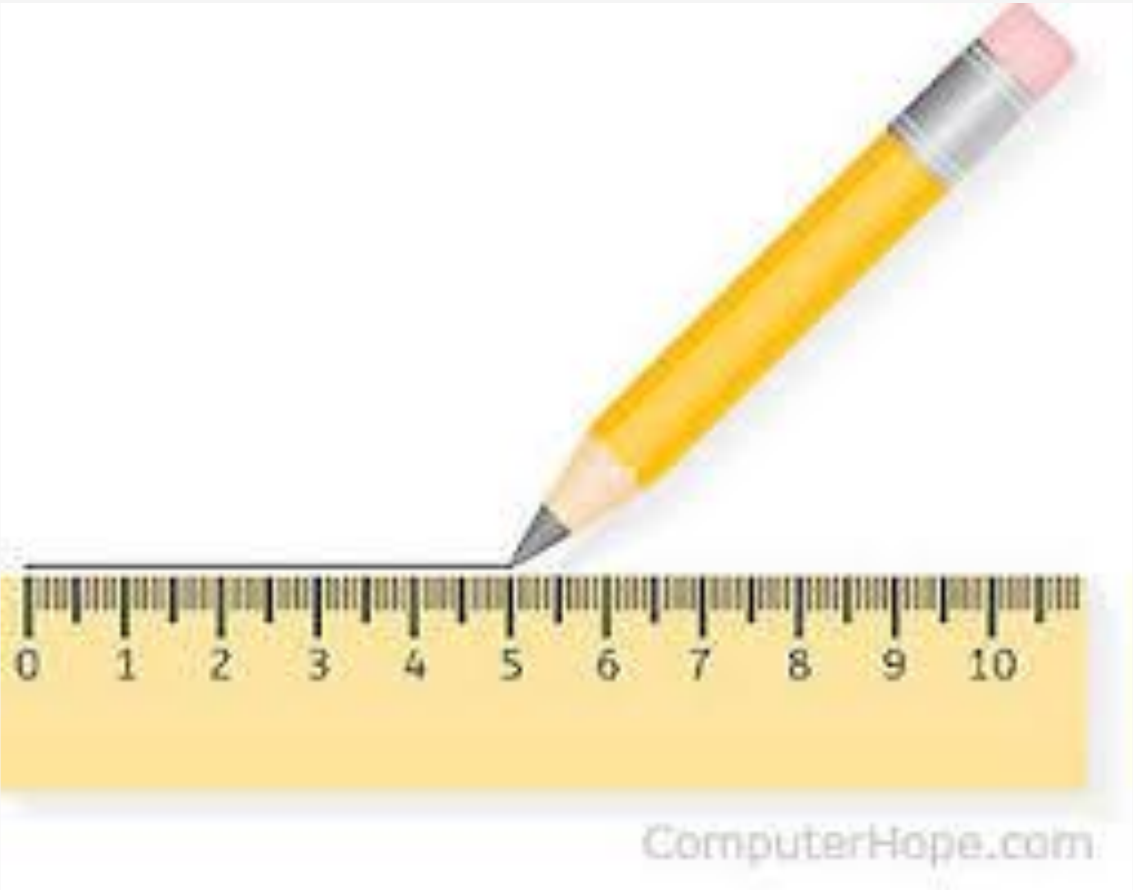
10.3 Survey Report

The Surveyors in charge shall submit a comprehensive survey report (2 copies) details on Outline of Operation, Field Operation, Data Processing, Finding, List of Accompanying Documents, and any other relevant information of each survey carried.

10.4 Digital Data File:

Hydrographers shall submit a set of all digital survey record mentioned in clause 8, and store the soft copy in CD together with an index chart let showing the surveyed areas covered by each data file and the co-ordinates for those points defining the surveyed areas.

Runlines



Line spacing

Line spacing
refers to the distance between tracks to be run by the survey vessel. It is chosen to provide the best coverage of the area using the equipment available. Line spacing is a function of the depth of water, the sound footprint of the collection equipment to be used, and the complexity of the bottom.

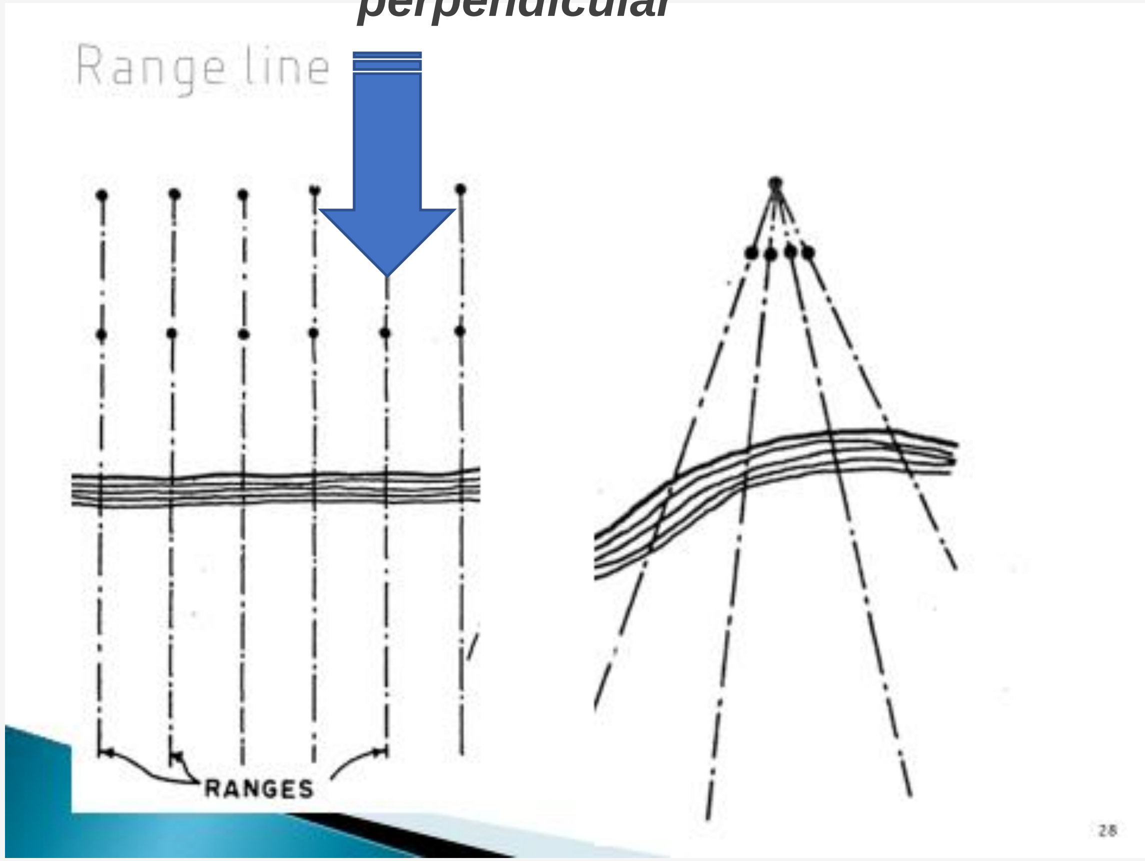
Sounding Lines

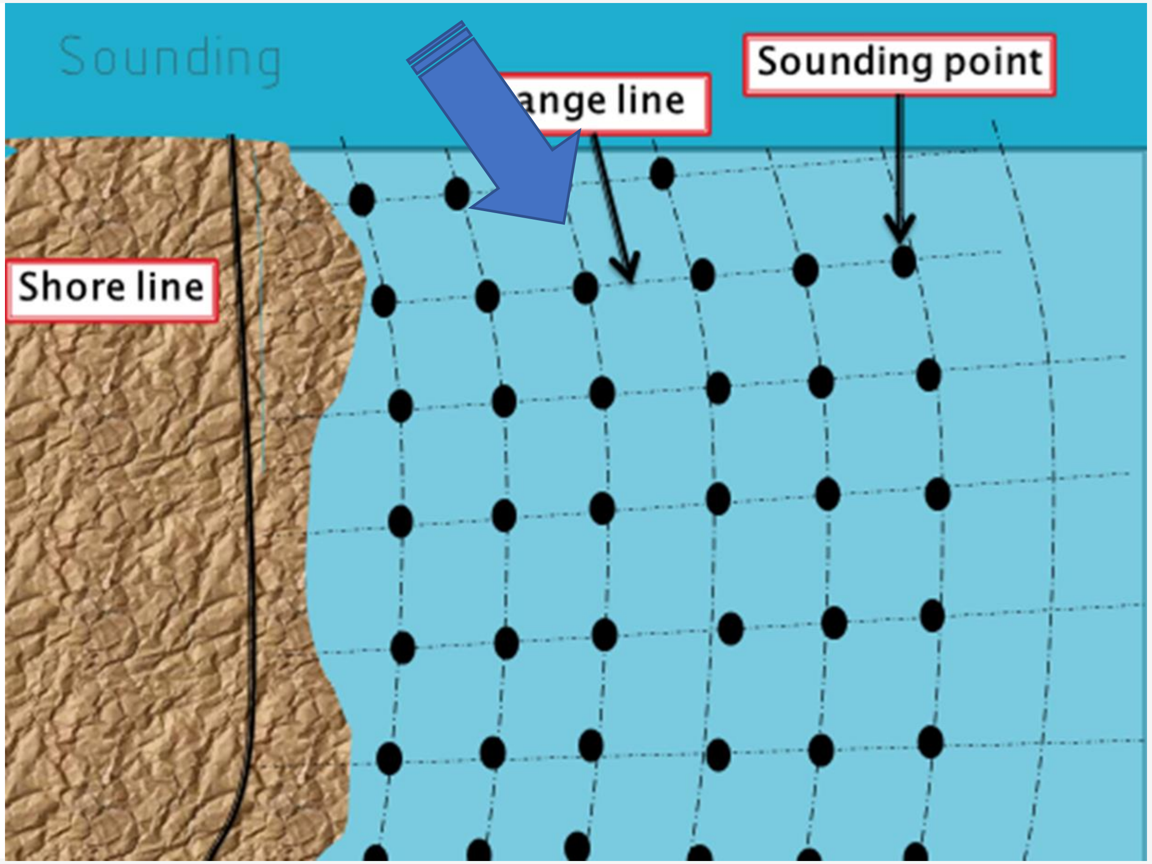
- Systems of Sounding Lines
  - Parallel straight lines –< open coasts
  - Radiating lines –< small bays and islets
  - Circular curves or arcs –< isolated shoal
- Spacing of Sounding Lines
  - Factors: the **scale** of the survey, **depth** of water, **proximity** to shore, **character** of submarine relief, **importance** of the region

Scale	Ordinary Spacing	Closest Spacing
1:10,000	50-60	25-30
1:20,000	100-125	50-60
1:40,000	200-250	100-125
1:80,000	400-500	200-250
1:120,000	600-750	300-375

Singlebeam – Runlines - perpendicular

Multibeam – Runlines - parallel





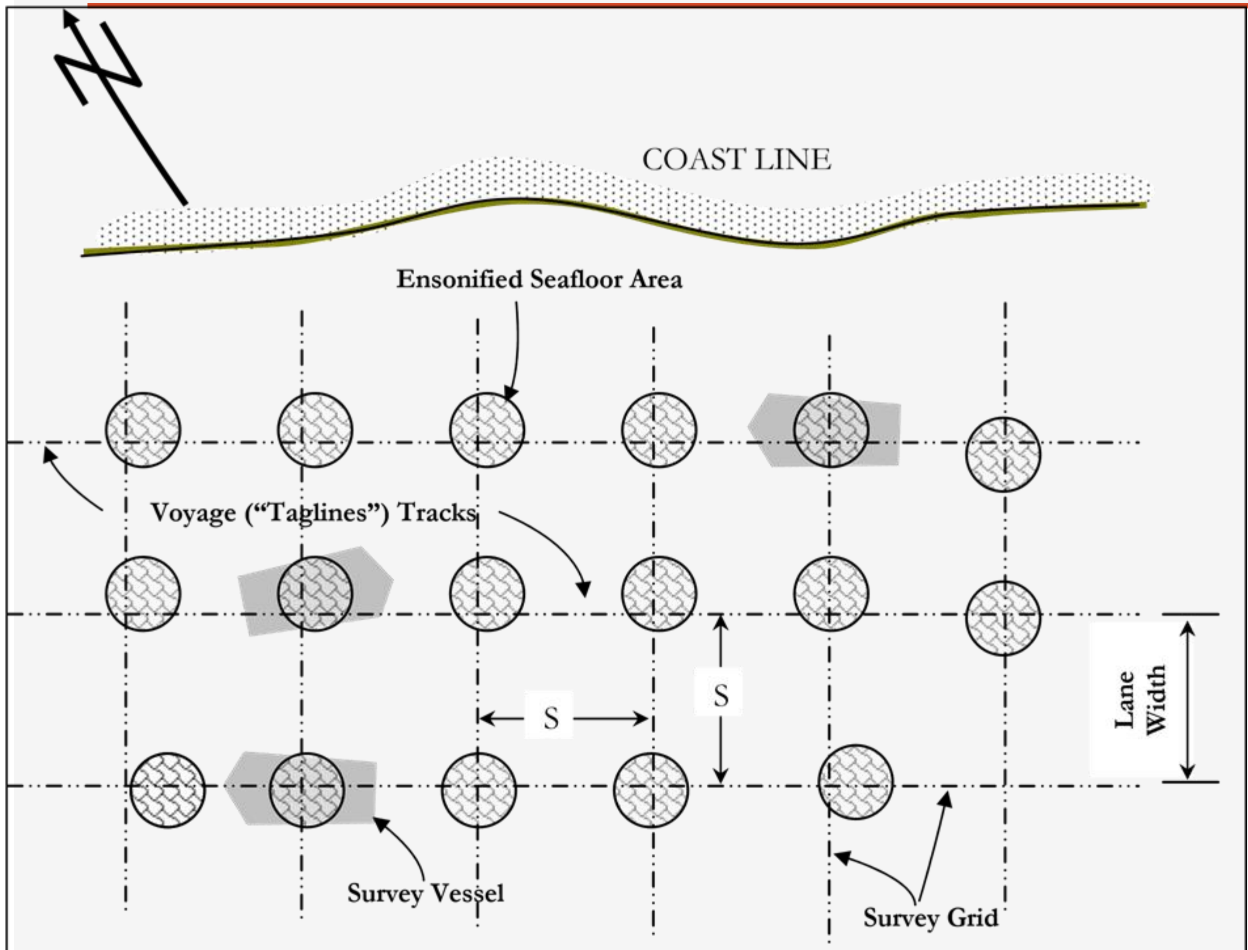


Figure 4.1: Survey Design and Field Campaign for Single beam

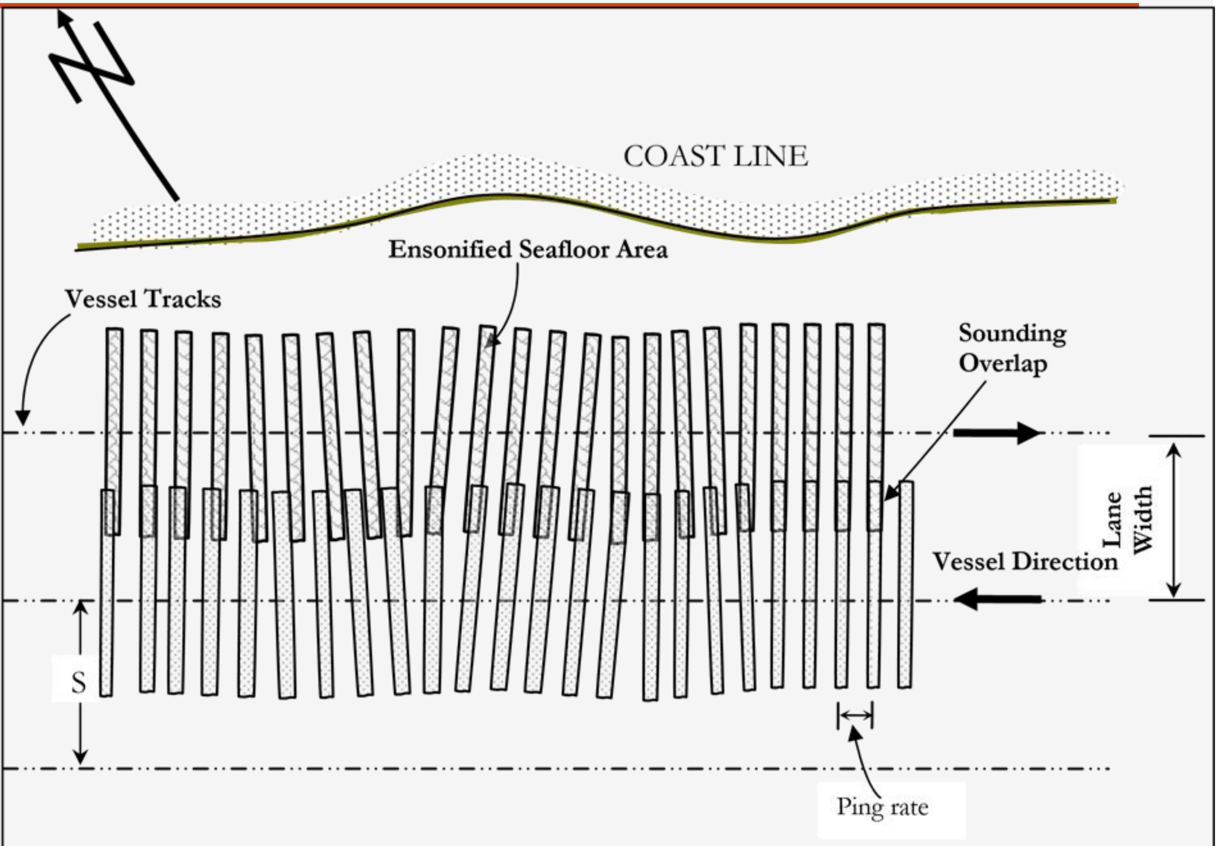
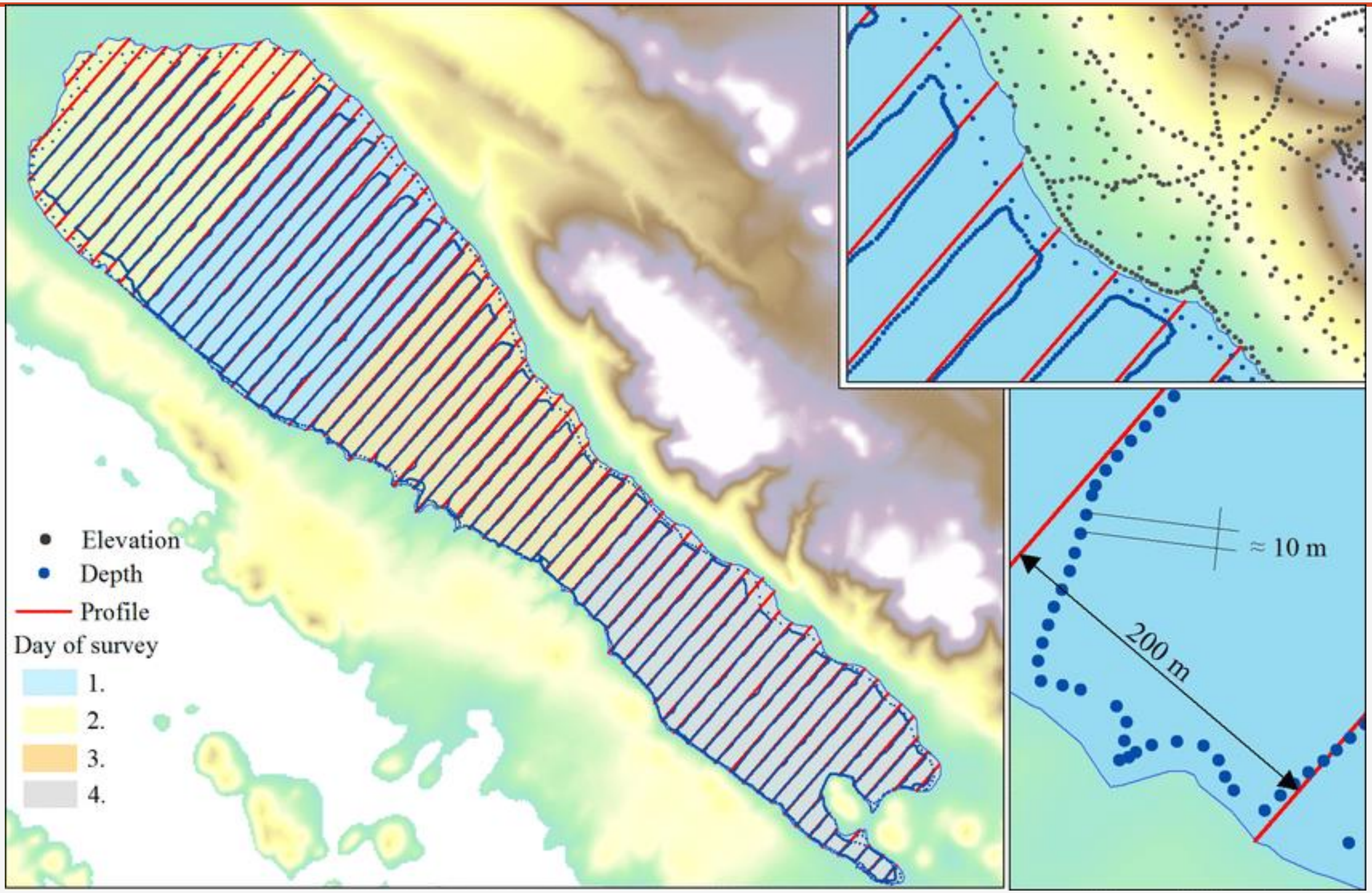
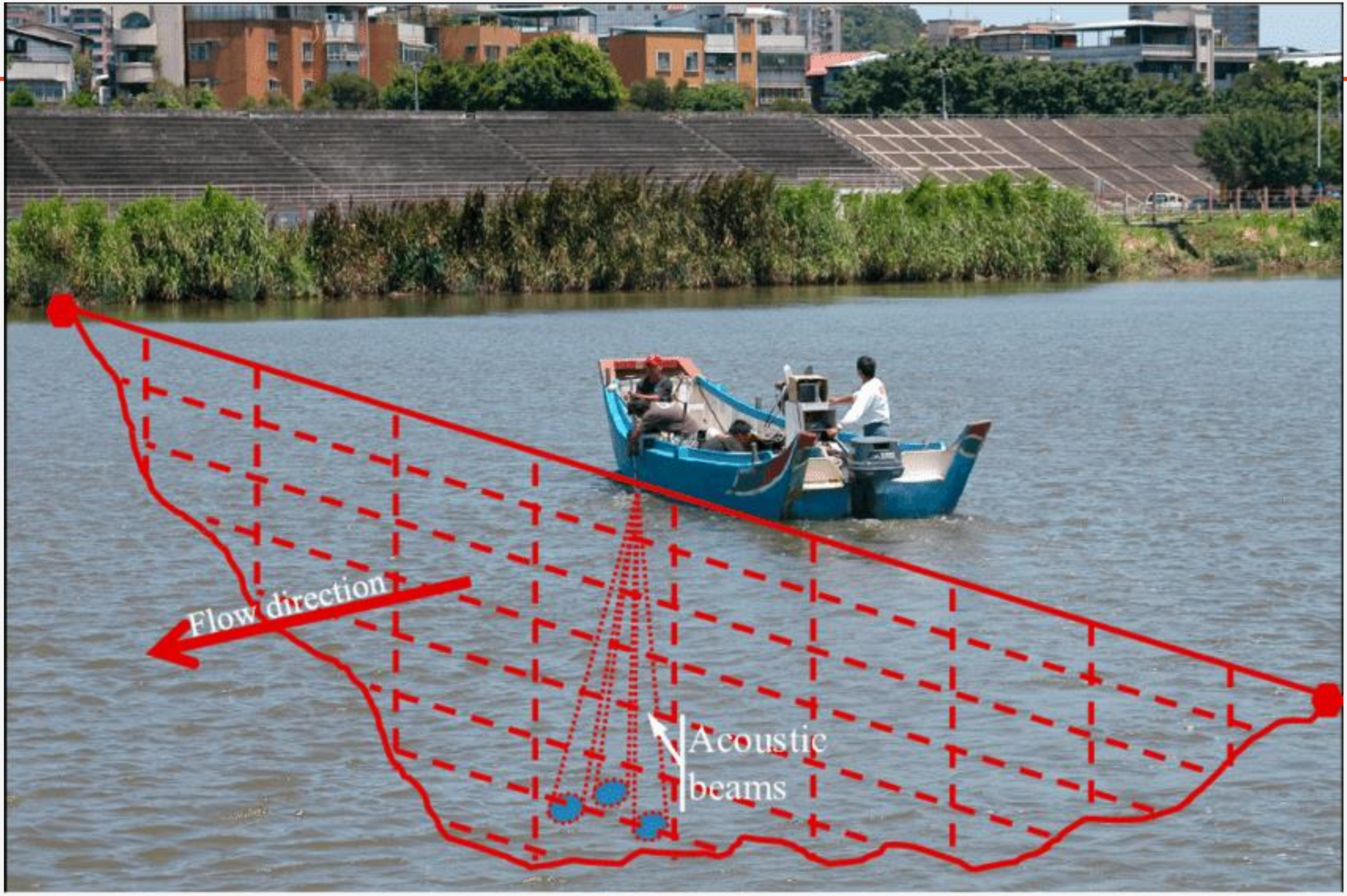


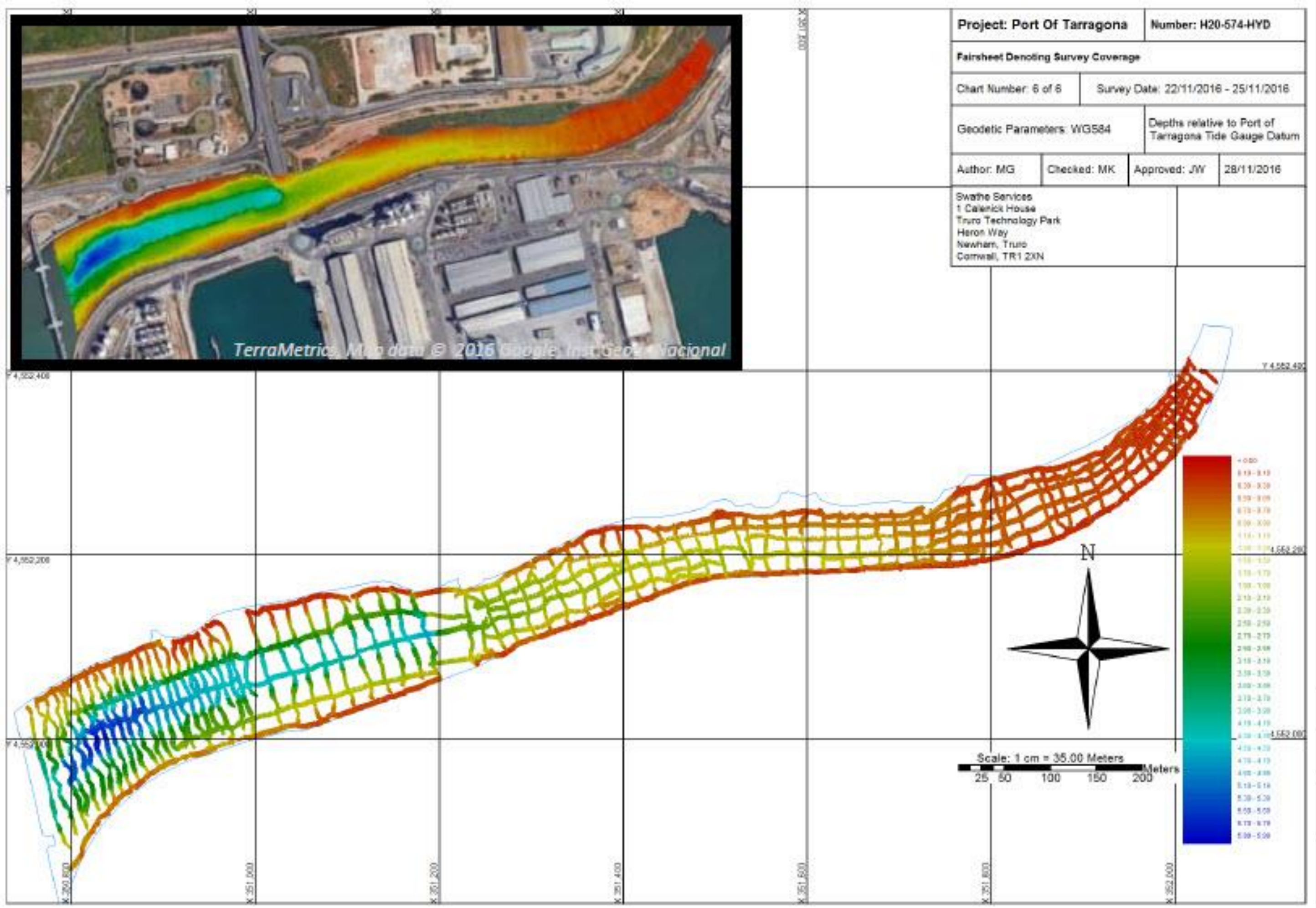
Figure 4.1: Survey Design and Field Campaign for Sweep Multibeam Surveys

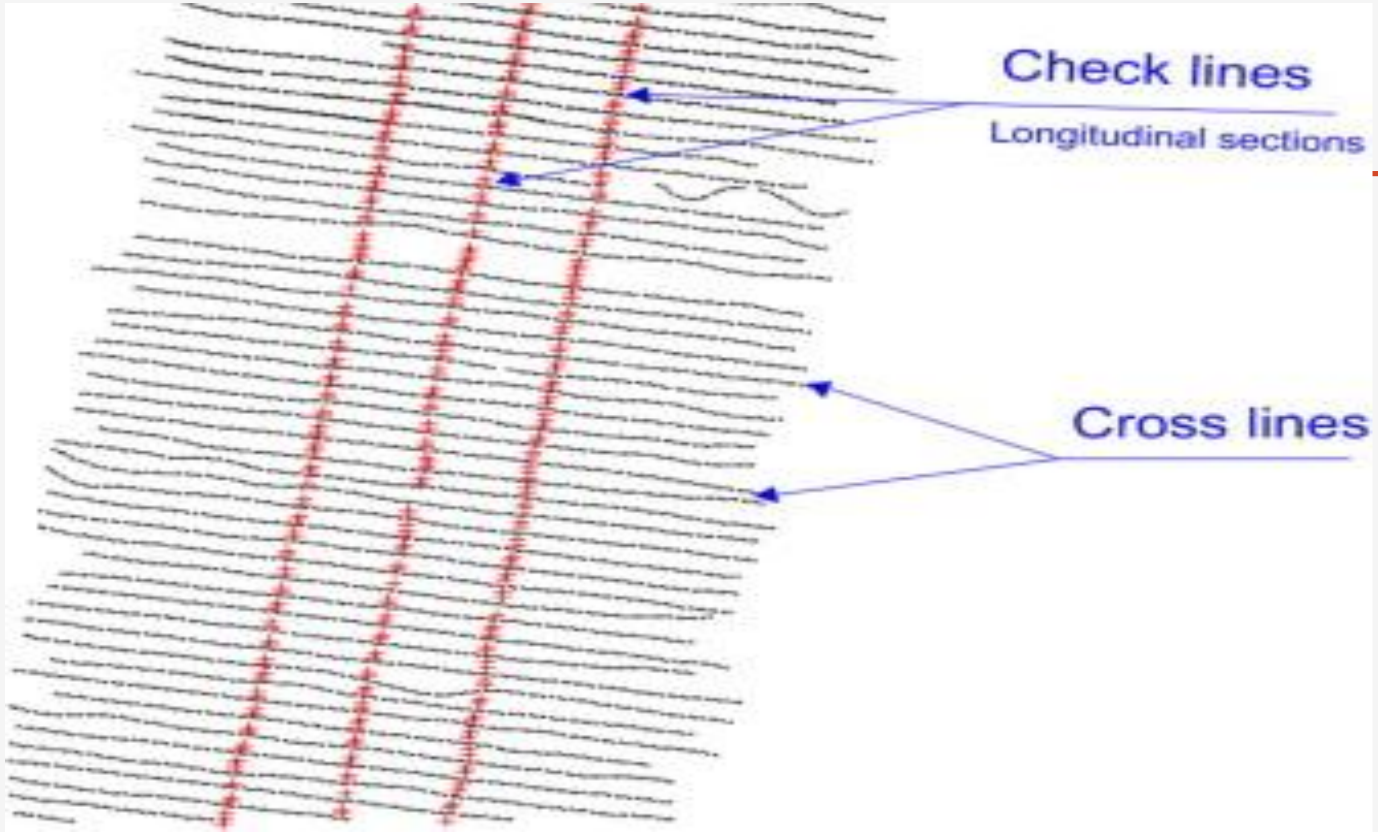
Run Line



Runline




TerraMetrics, Map data © 2016 Google, Inst. Geogr. Nacional
Project: Port Of Tarragona
Number: H20-574-HYD
Fairsheet Denoting Survey Coverage
Chart Number: 6 of 6
Survey Date: 22/11/2016 - 25/11/2016
Geodetic Parameters: WGS84
Depths relative to Port of Tarragona Tide Gauge Datum
Author: MG
Checked: MK
Approved: JW
28/11/2016
Swathe Services
1 Calenick House
Truro Technology Park
Heron Way
Newham, Truro
Cornwall, TR1 2XN
N
Scale: 1 cm = 35.00 Meters
25 50 100 150 200
Meters



Locations of the main lines (cross lines) and check lines (longitudinal lines) for bathymetric survey used in the first evaluation method.

Check lines crossing the regular lines are always done to confirm the accuracy of the positioning, the depth measurement, and other depth corrections. They are run as close to perpendicular to the principal lines as possible. The differences between principal lines and check lines have to fall within the limits of the survey order. When discrepancies exceed the permissible amount, the soundings must be carefully examined to determine the possible sources of error: tide or water level, sea state, beam angle, position errors, calibration errors, corrections used, etc. Once the sources of error have been determined, corrective action must be taken. This work should be done as soon as possible as the survey progresses. In some cases, it may be necessary to resurvey the portion of the area that is subject to disagreement with the check lines

Scale

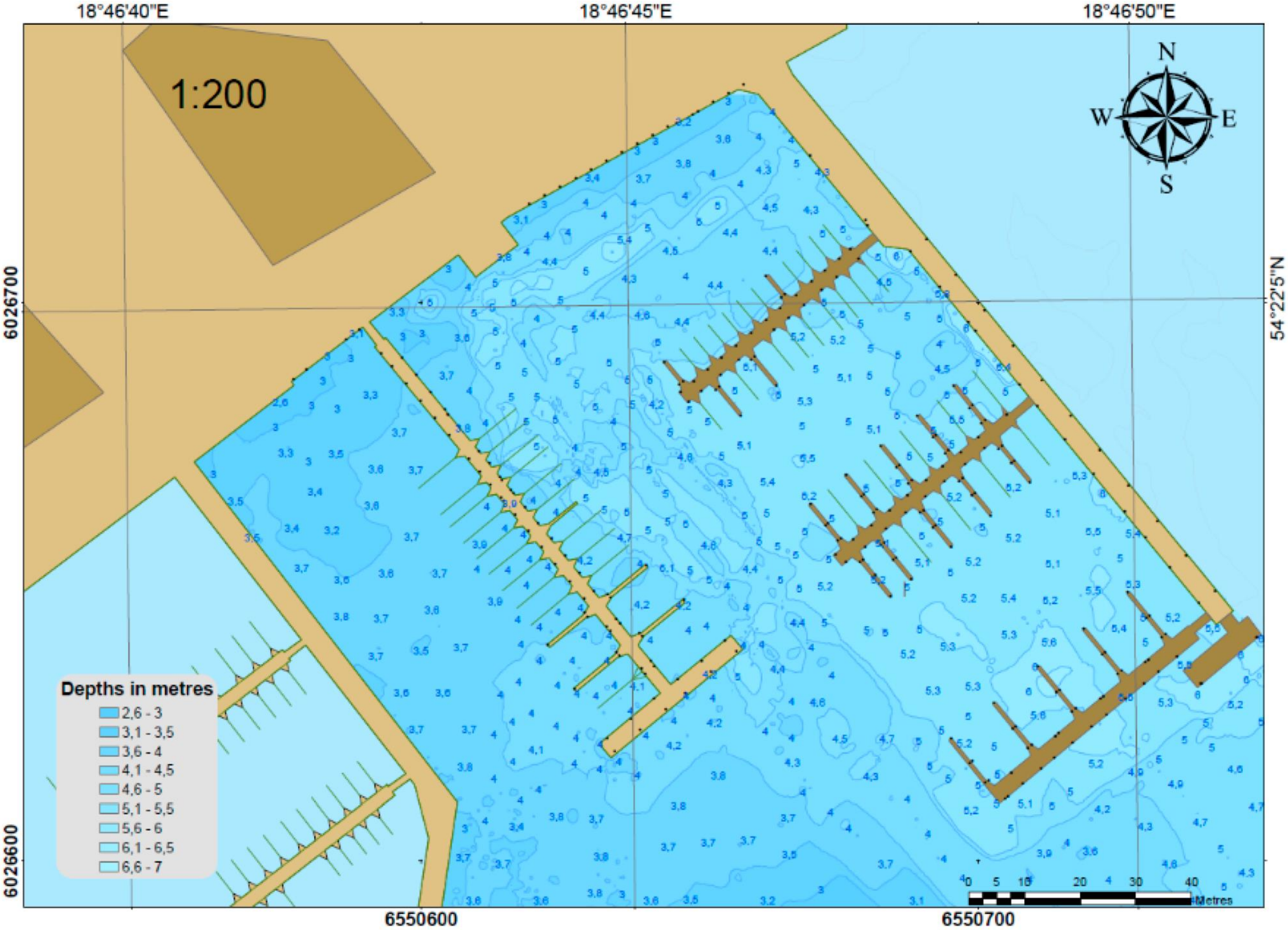
1/2500 x 25m interval on the ground = 10cm on paper

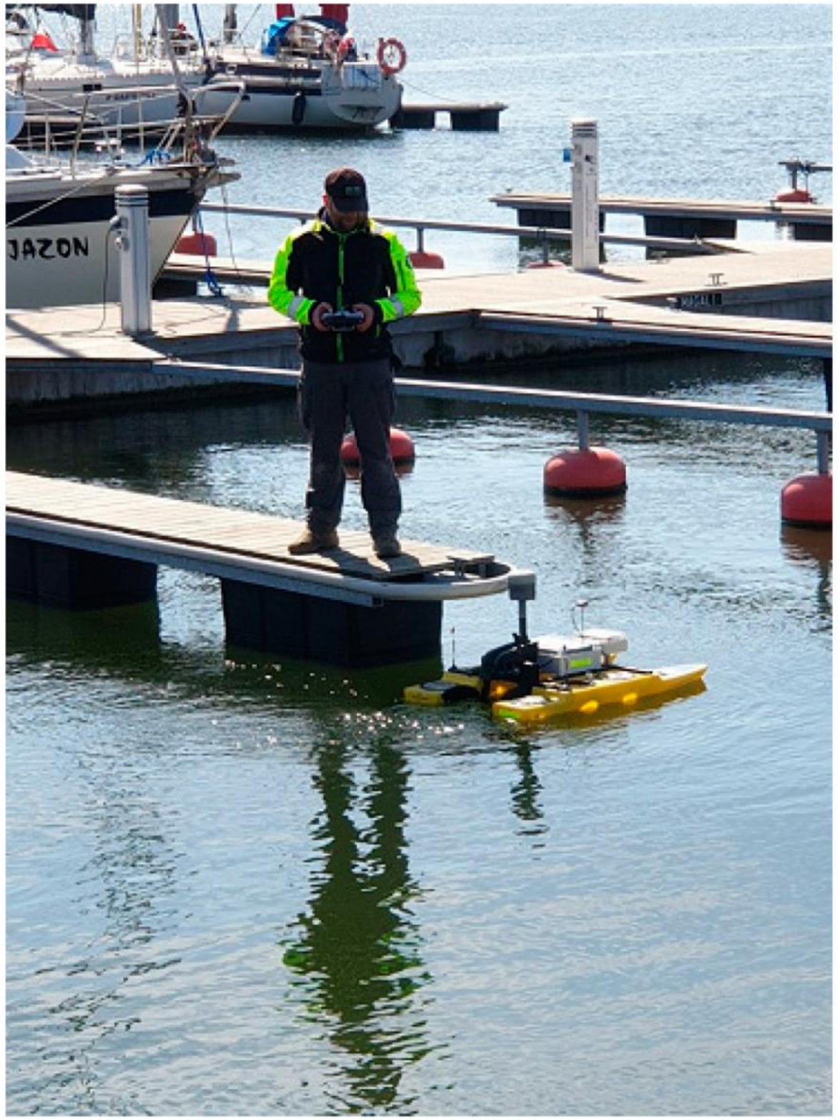
1/5000 x 50m interval on the ground = 10cm on paper

1/5000 x 25m interval on the ground= 0.5cm on paper

1/2500 x 100cm = 25m on the ground

1/5000 x 100cm = 50m on the ground


18°46'40"E
18°46'45"E
18°46'50"E
1:200
N
W
E
S
6026700
6026600
54°22'5"N
6550600
6550700
0 5 10 20 30 40
Metres
Depths in metres
2,6 - 3
3,1 - 3,5
3,6 - 4
4,1 - 4,5
4,6 - 5
5,1 - 5,5
5,6 - 6
6,1 - 6,5
6,6 - 7


JAZON

(a)


18°46'40"E
18°46'45"E
18°46'50"E
54°22'5"N
6026700
6026650
6026600
6550550
6550600
6550650
6550700
6550750
N
S
W
E
0 5 10 20 30 40
Metres

(b)

Scale

1/2500 x 25m interval on the ground = 10cm on paper

1/5000 x 50m interval on the ground = 10cm on paper

1/5000 x 25m interval on the ground= 0.5cm on paper

1/2500 x 100cm = 25m on the ground

1/5000 x 100cm = 50m on the ground

4.2 Data Processing

Last day event

https://youtu.be/7bxbfKoAteE

Data Processing

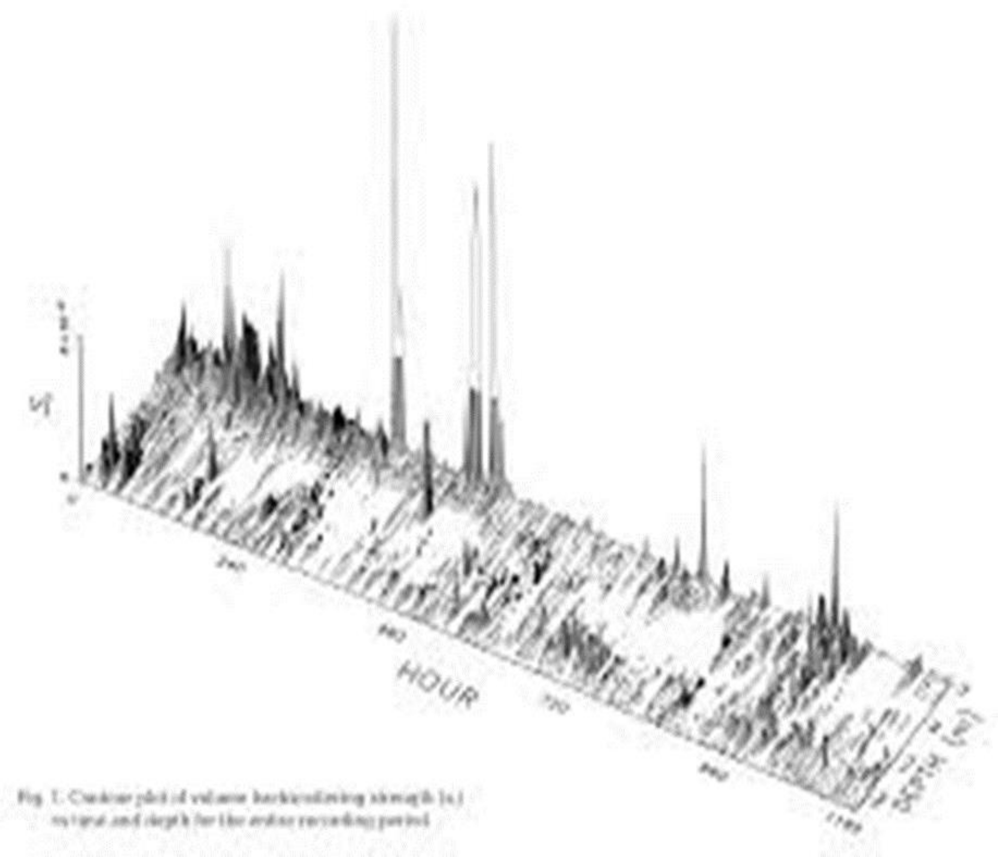
Data Processing

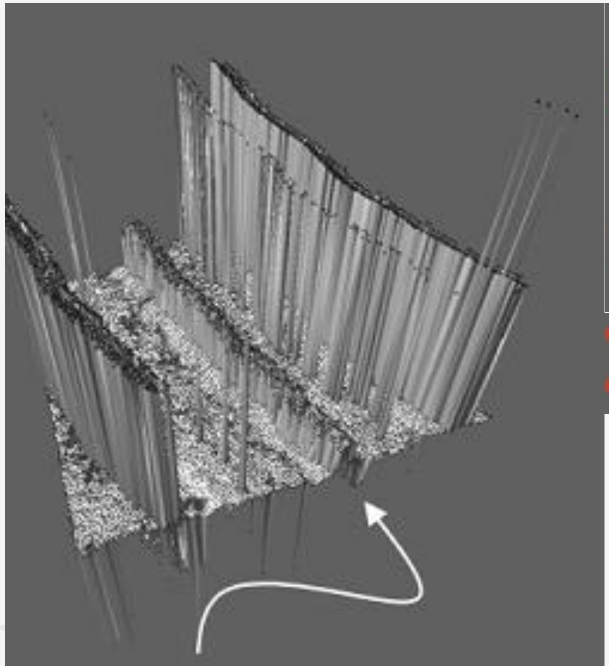
Conventional surveys require post processing of total station (distance, Azimuth, and vertical angle) data to compute “time-stamped” intersections (x, y, Depth) points.

Electronic (acoustic) methods require automated data processing. Complex data analysis includes tidal correction, the application of the depth reduction equation, removing artifacts from the dataset, setting beam angles, sorting parameters, and various other parameters. Data processing converts data from a raw state into various user defined products.

Bathymetric chart (contour) lines are generated by a suitable interpolation method using the depths at the grid nodes.

Interfering signals originating from a multitude of natural and technogenic (man-made) phenomena often have intrinsic “outlier” temporal and/or amplitude structures that are different from the Gaussian structure of the thermal noise. The presence of different types of such outlier noise is widely acknowledged in multiple applications, under various general and applicationspecific names, most commonly as impulsive, transient, burst, or crackling noise.





A pipeline surrounded by two ribbons of structural noise.

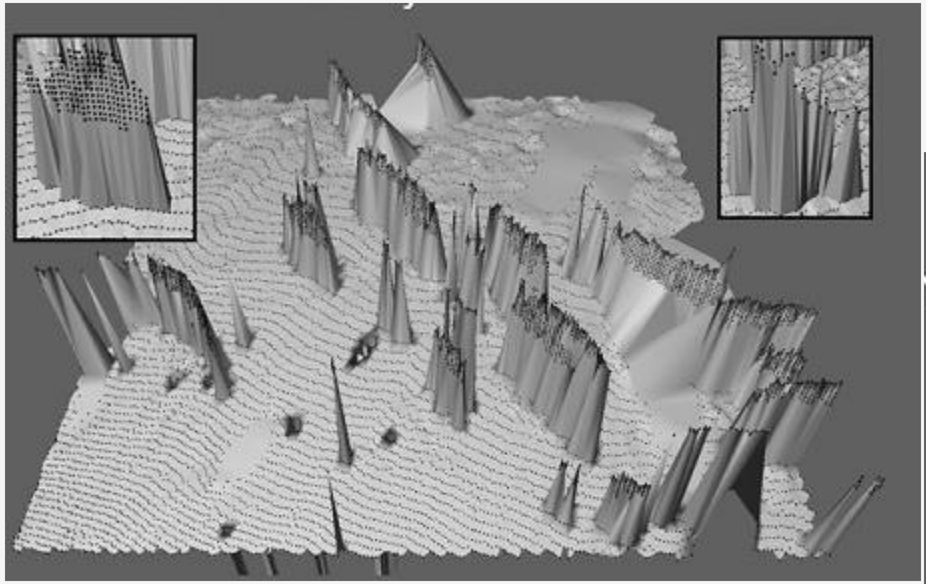
What’s the problem?

- Not only features on the terrain are reported.
  - Data includes fish and other non-permanent objects in the water.
- Spurious measurements.
  - E.g. refraction in gas bubbles.
- Miscalibration of devices causes systematic errors.
- Sensor inaccuracy.

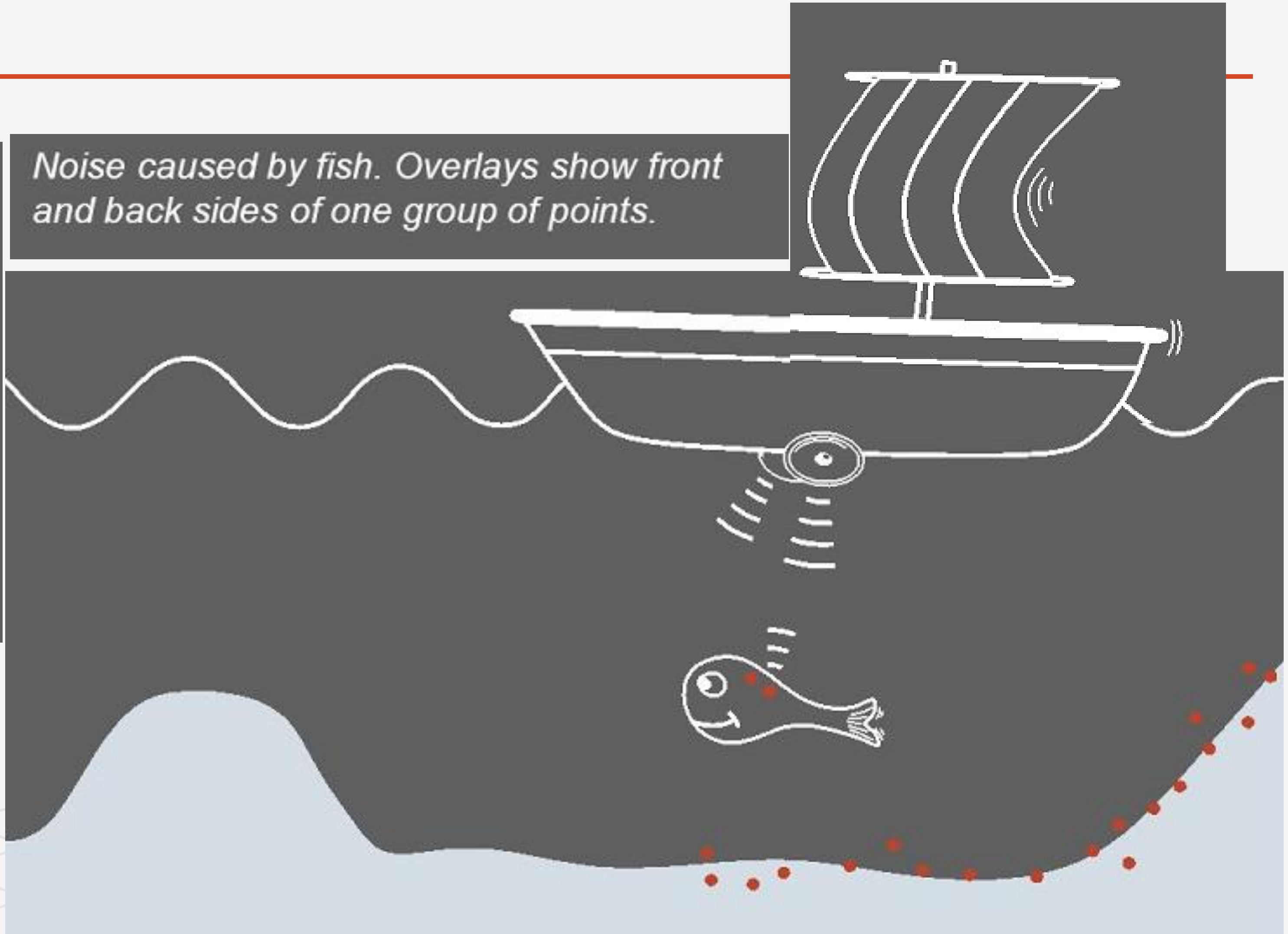
Outliners

The first one is a simple lack of motivation. Without using nonlinear filtering techniques the resulting signal quality is largely invariant to a particular time-amplitude makeup of the interfering signal and depends mainly on the total power and the spectral composition of the interference in the passband of interest. Thus, unless the interference results in obvious, clearly identifiable outliers in the signal's band, the "hidden" outlier noise does not attract attention.

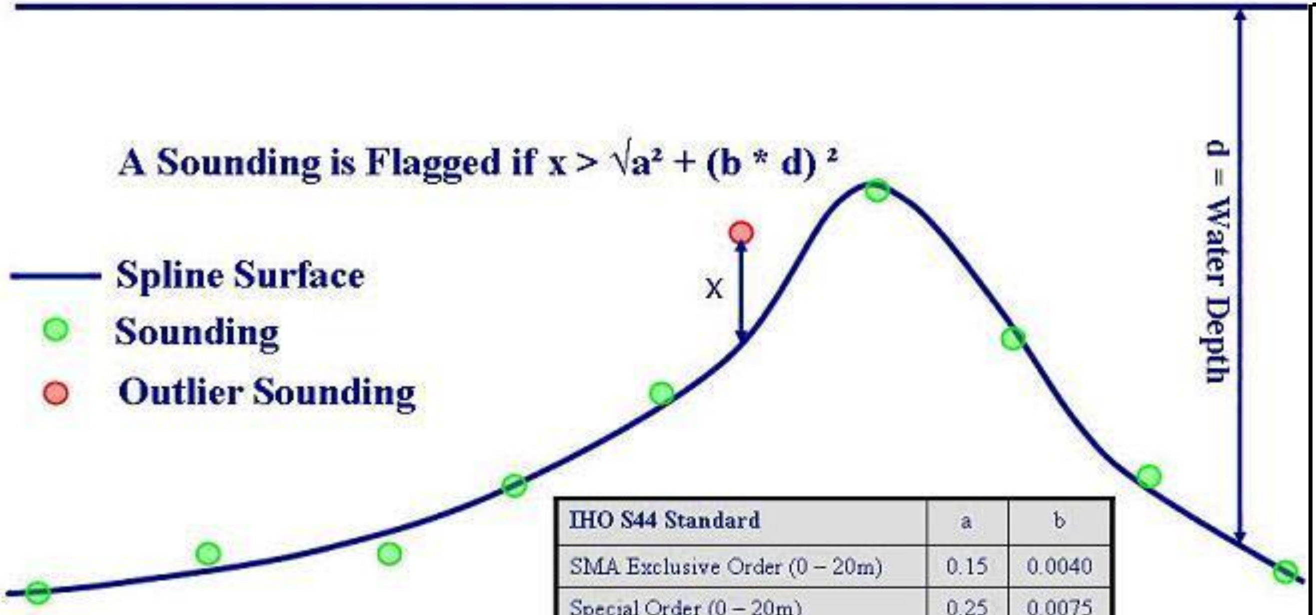
The second reason is the highly ambiguous and elusive nature of outlier noise, and the inadequacy of tools used for its consistent observation and/or quantification. More important, the amplitude distribution of a non-Gaussian signal is generally modifiable by linear filtering, and such filtering can often convert the signal from sub-Gaussian into super-Gaussian, and vice versa. Thus apparent outliers in a signal can disappear and reappear due to various filtering effects, including fading and multipath, as the signal propagates through media and/or the signal processing chain



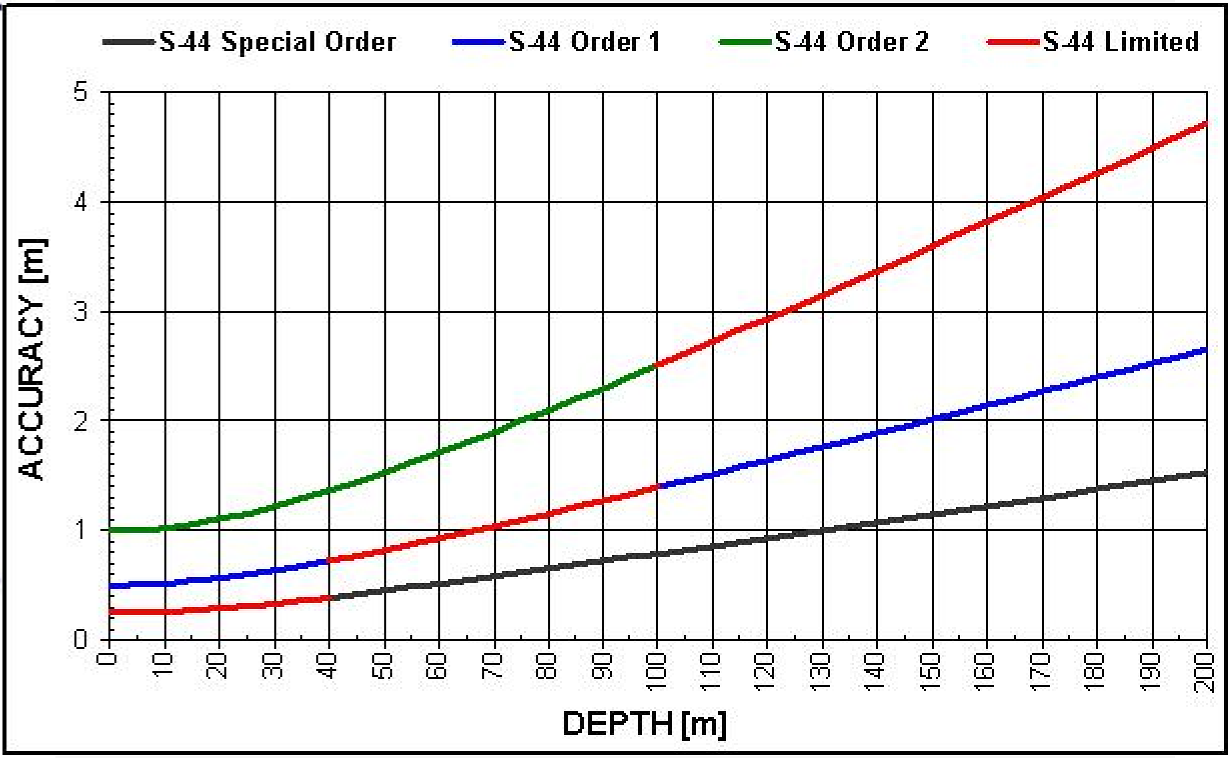
Noise caused by fish. Overlays show front and back sides of one group of points.



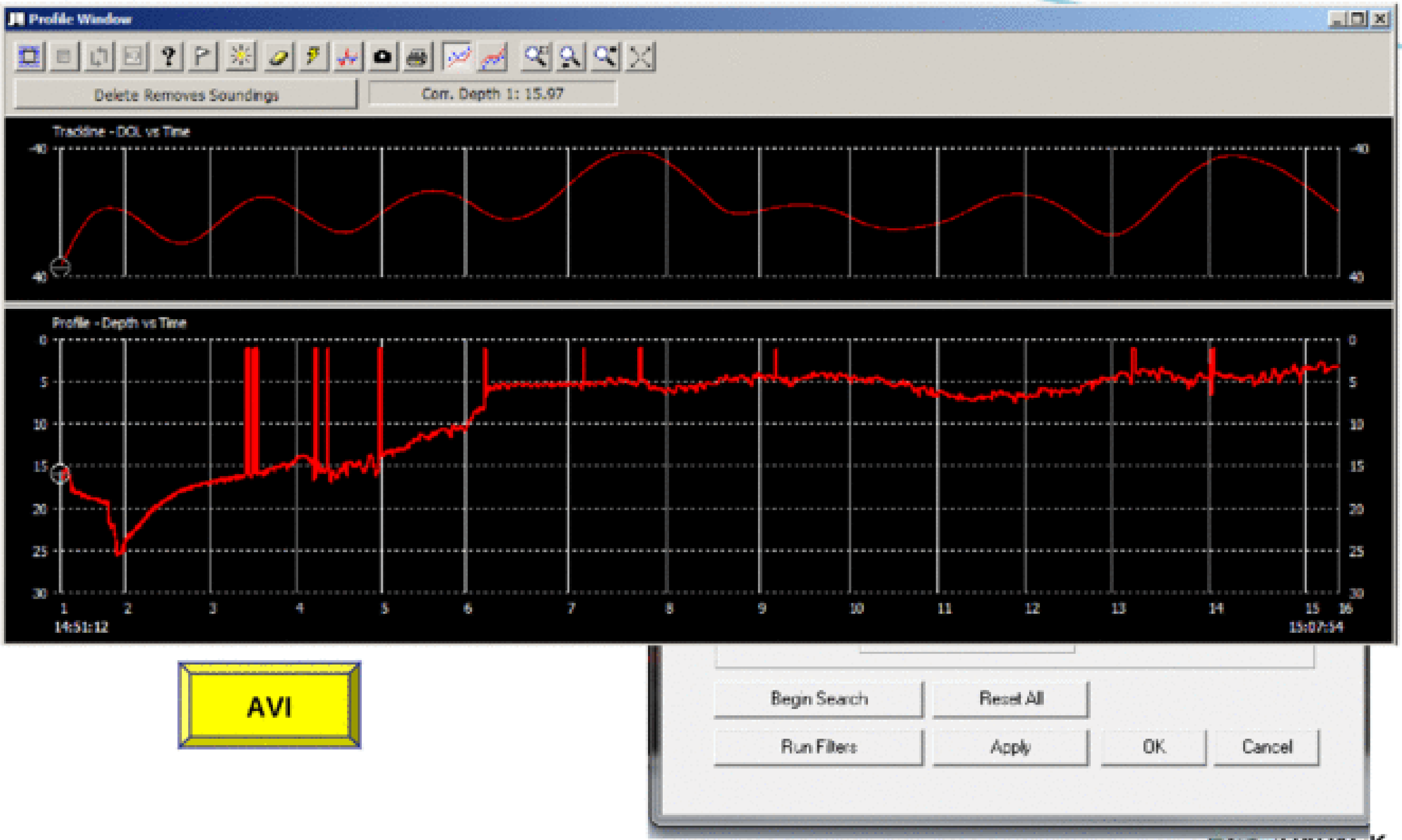
IHO S44 Guidelines for Outlier Detection



IHO S44 Standard	a	b
SMA Exclusive Order (0 – 20m)	0.15	0.0040
Special Order (0 – 20m)	0.25	0.0075
First Order (20 – 50m)	0.50	0.0130
Second Order (50 – 100m)	1.00	0.0230
Extremely High Detail (0 – 10m)	0.05	0.0020

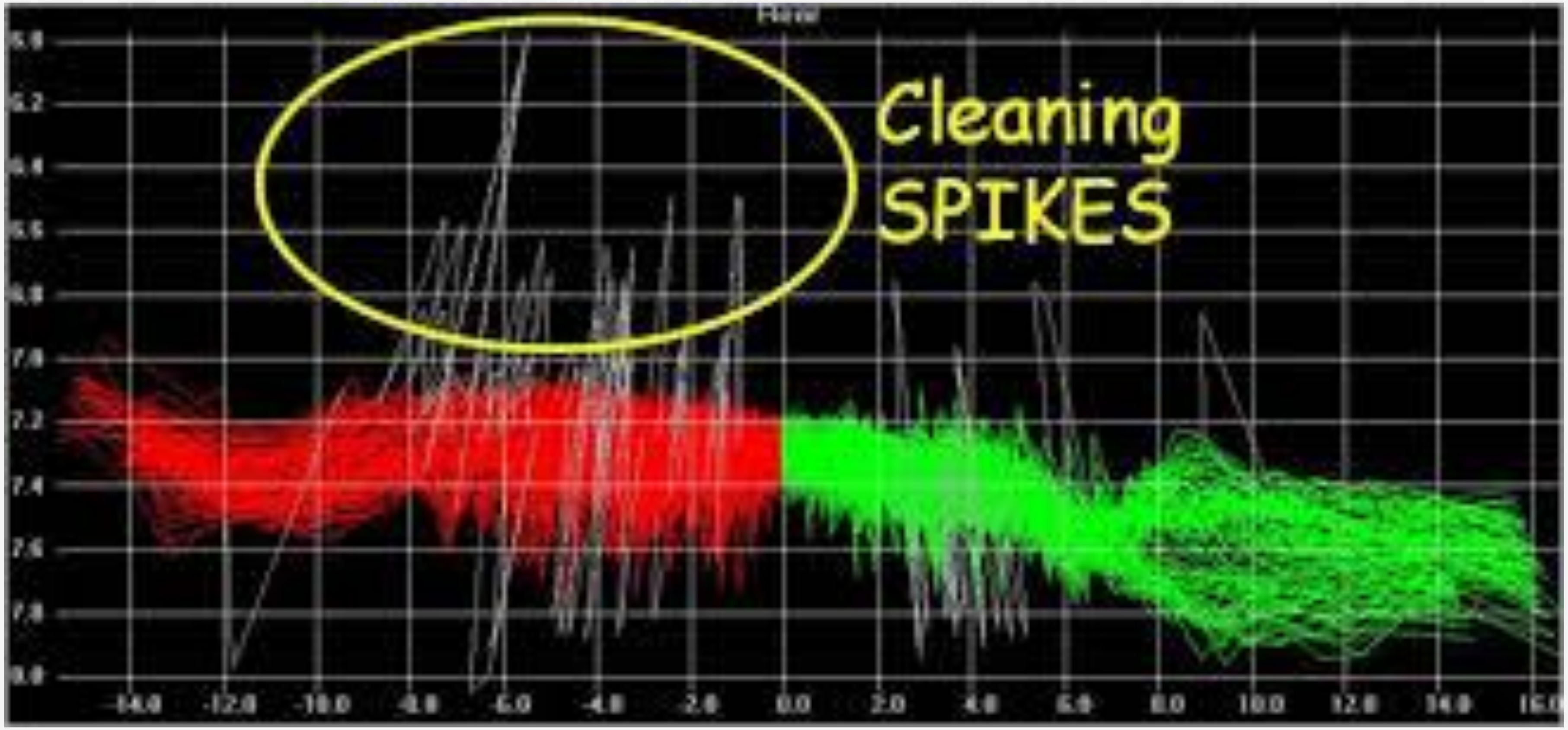


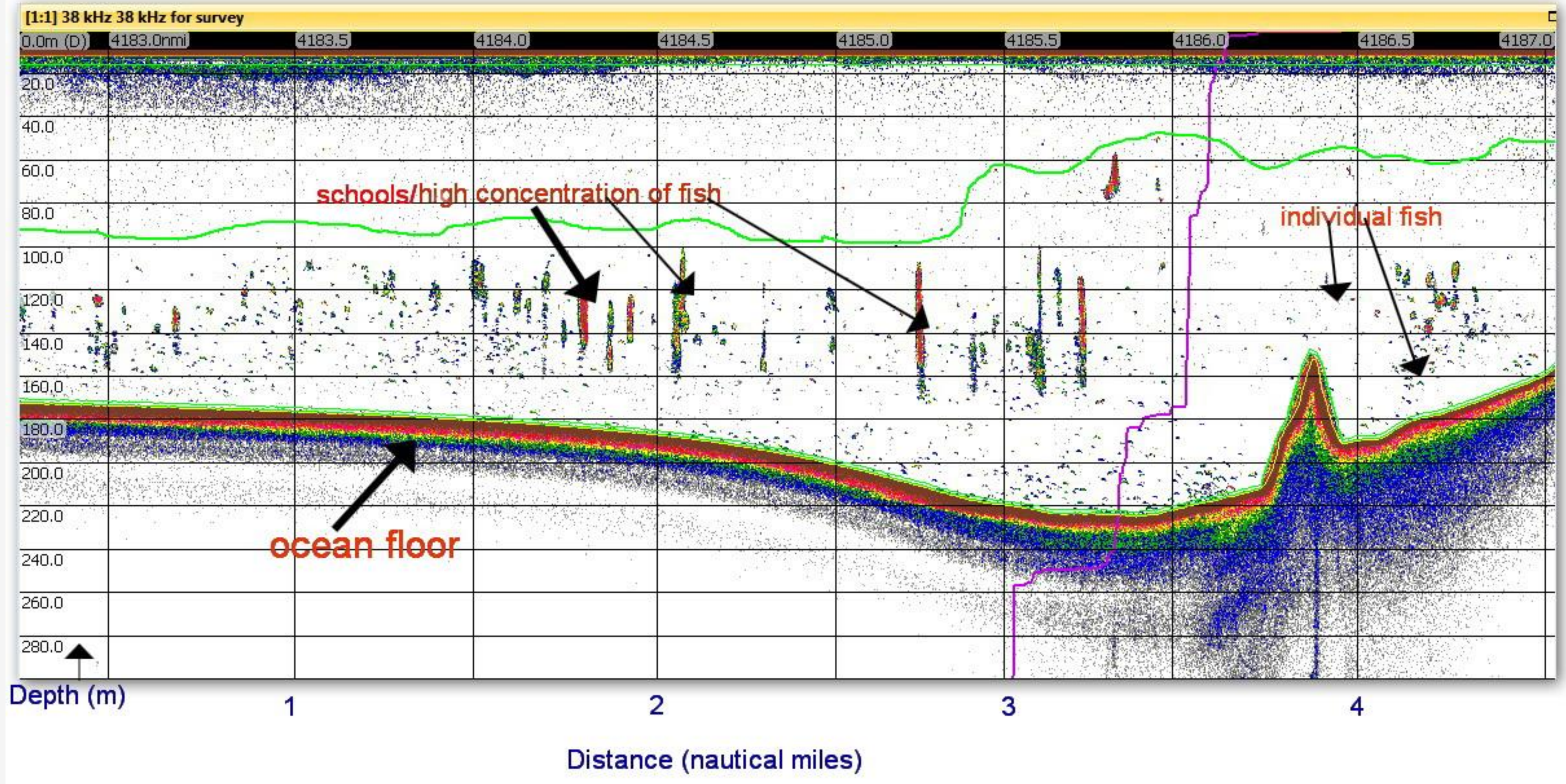
Filters



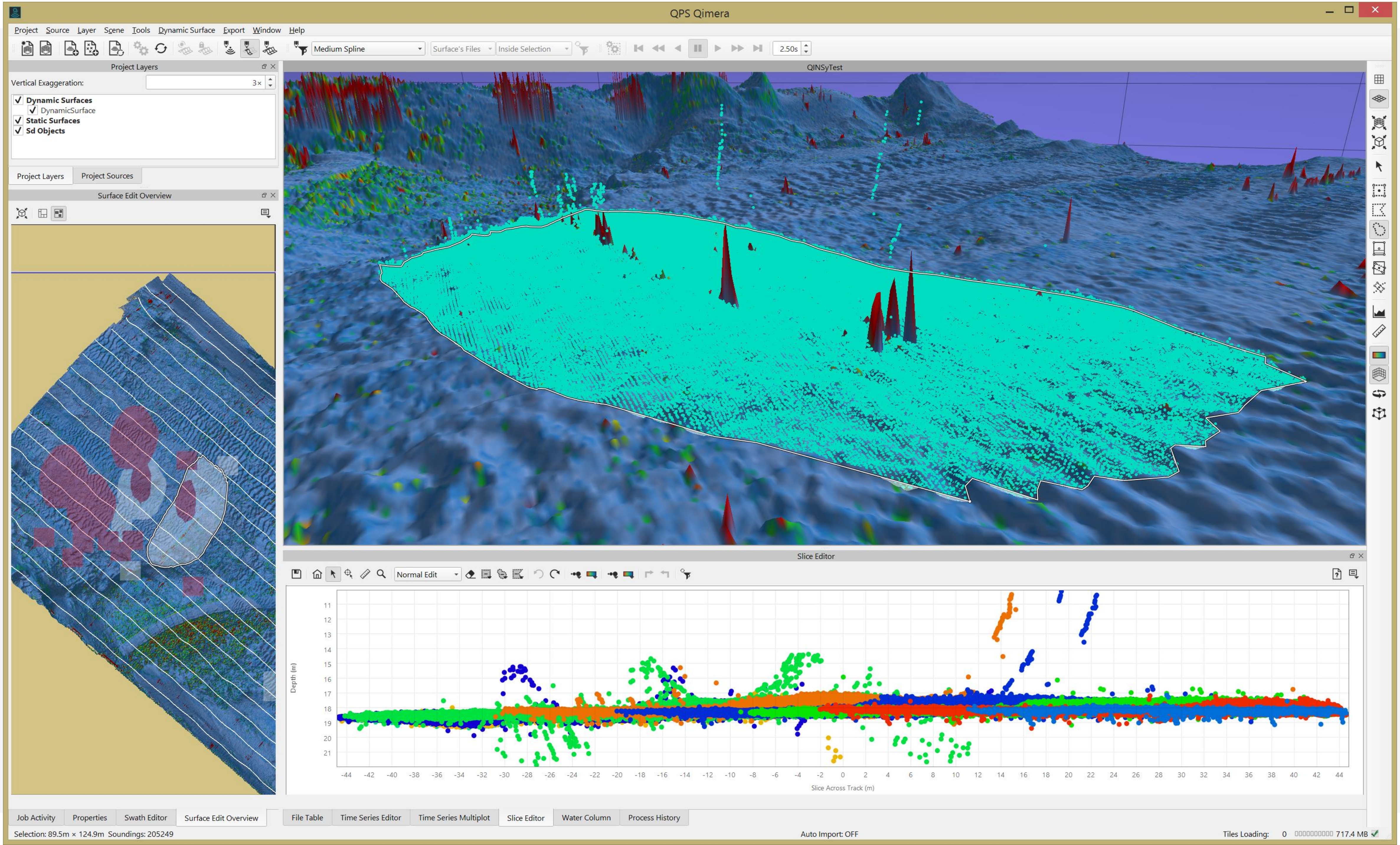
AVI

HYPACK
a xylem brand

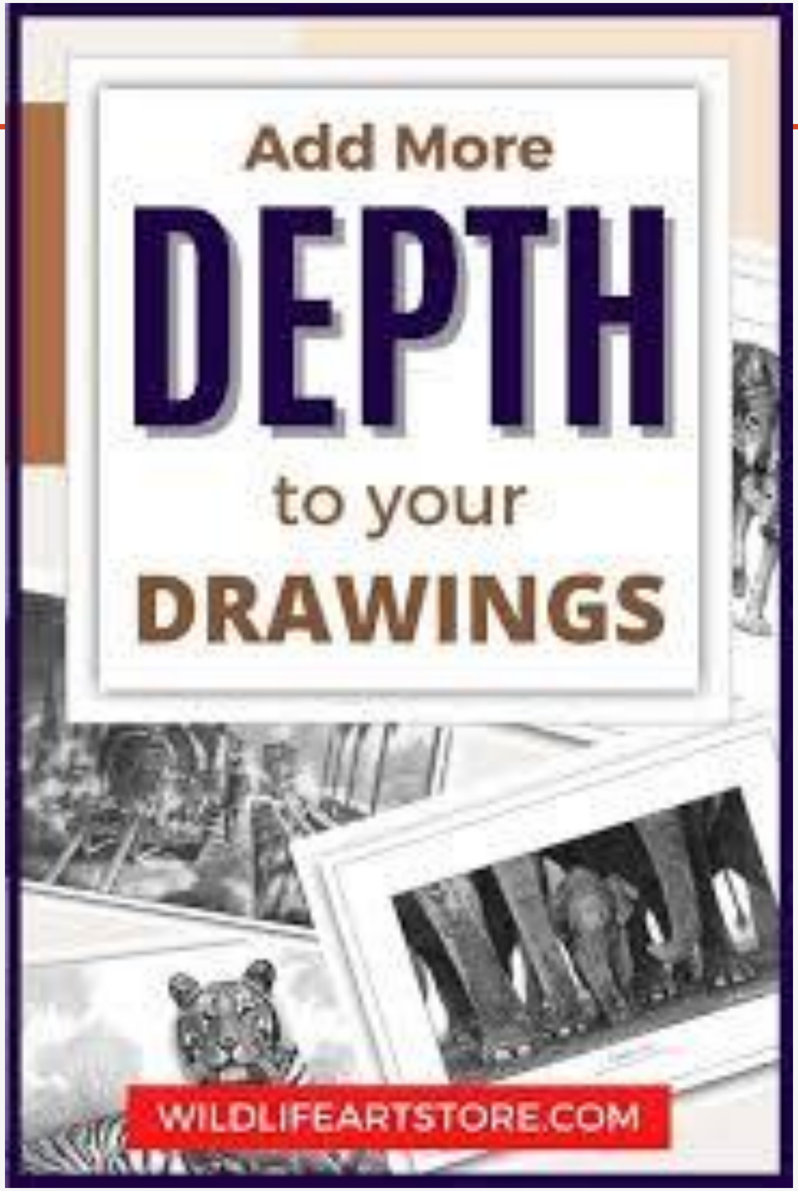

Cleaning
SPIKES
-14.0
-12.0
-10.0
-8.0
-6.0
-4.0
-2.0
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0

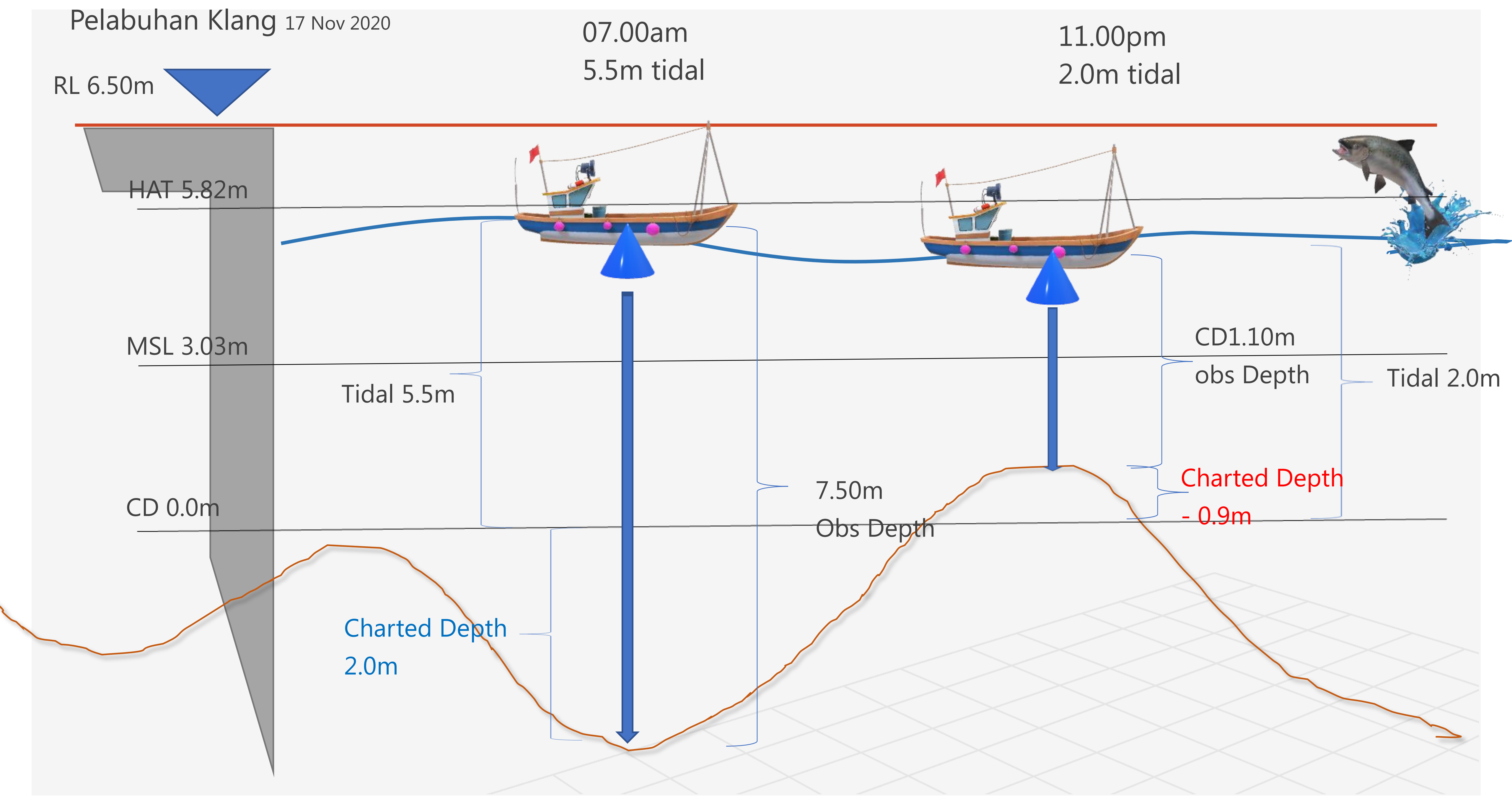


[1:1] 38 kHz 38 kHz for survey
0.0m (D)
4183.0nmi
4183.5
4184.0
4184.5
4185.0
4185.5
4186.0
4186.5
4187.0
20.0
40.0
60.0
80.0
100.0
120.0
140.0
160.0
180.0
200.0
220.0
240.0
260.0
280.0
schools/high concentration of fish
individual fish
ocean floor
Depth (m)
1
2
3
4
Distance (nautical miles)


QPS Qimera
Project Source Layer Scene Tools Dynamic Surface Export Window Help
Medium Spline
Surface's Files
Inside Selection
2.50s
Project Layers
Vertical Exaggeration:
3x
Dynamic Surfaces
DynamicSurface
Static Surfaces
Sd Objects
Project Layers
Project Sources
Surface Edit Overview
QINSyTest
Slice Editor
Normal Edit
Depth (m)
Slice Across Track (m)
Job Activity
Properties
Swath Editor
Surface Edit Overview
File Table
Time Series Editor
Time Series Multiplot
Slice Editor
Water Column
Process History
Selection: 89.5m × 124.9m Soundings: 205249
Auto Import: OFF
Tiles Loading: 0
717.4 MB

Reduce Depth




Pelabuhan Klang 17 Nov 2020
07.00am
5.5m tidal
11.00pm
2.0m tidal
RL 6.50m
HAT 5.82m
MSL 3.03m
CD 0.0m
Tidal 5.5m
7.50m
Obs Depth
Charted Depth
2.0m
CD1.10m
obs Depth
Tidal 2.0m
Charted Depth
- 0.9m

IHO Standards

In an effort to achieve standardization of nautical charts and other products, the IHO has published standards that cover many aspects of hydrography. These include:

S-4: Standard for Nautical Charts
S-5 and S-8: Competency Standards for Hydrographic Surveyors and Cartographers
S-32: Hydrographic Dictionary
S-44: Standards for Hydrographic Surveys
S-57: Standards for Electronic Navigational Charts (ENCs)
S-52: Standards for systems that display ENCs.
S-100: Universal Hydrographic Data Model

These standards have made it possible for mariners to use charts compiled by member organizations with confidence.

Text Note: IHO Publications available at http://www.iho-ohi.net/iho_pubs/IHO_Download.htm